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ABSTRACT

This report was prepared to present reviews, synthesis, and evaluation of research studies and demonstration projects concerned with the labor market experience of unemployed engineers, particularly in aerospace-defense. It also includes a review and evaluation of national manpower efforts to aid the reemployment of unemployed engineers, scientists, and technicians as well as the state-of-the-art of forecasting the demand and supply of engineers and scientists. Recommendations for future public and private manpower efforts devoted to engineers' employment are presented. The report also includes a bibliography of the literature on the subject and an annotated bibliography of Office of Research and Development (ORD) programs. (Author/EB)

LABOR MARKET EXPERIENCE FOR ENGINEERS DURING PERIODS OF CHANGING DEMAND

Trevor Bain

Center for Policy Research, Inc.

Final Report

Submitted to:

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INTRODUCTION

In the middle of the 1950's the Soviet threat to United States technological superiority created considerable discussion about whether this country had a shortage of engineers and natural scientists. Among the reactions to this threat were the funding of a major American space program and expansion of enrollments in the engineering schools. A decade later, however, unemployment among engineers and scientists was a national manpower issue for by the end of the 1960's funding for the space program had declined and the growth in enrollments in engineering schools had ended. The rate of unemployment among engineers increased from 0.7 per cent to 2.9 per cent between 1967 and 1971, an increase much higher than that for all professionals. At the beginning of the 1970's newspaper and magazine articles reported the problems of unemployed engineers and scientists. These articles asserted that middle-aged engineers and scientists faced serious re-employment problems, experiencing long periods of unemployment and finally accepting inferior jobs.

The purpose of this study is to provide some answers to the many assertions that have been made about the labor market for engineers and to present recommendations for policies and programs in both the public and private sectors. These answers and recommendations are principally based on the results of a decade of research studies and demonstration projects funded by the Office of Research and Development (ORD), Manpower Administration, U. S. Department of Labor (DOL). This report is the author's own synthesis of projects supported by the Manpower Administration. Several additional sources are referred to; however, this project is not intended to cover the extensive literature on the subject. This study is also confined to the labor market for engineers. Data on this topic often includes three occupational groups: engineers, scientists and technicians, or, what are often referred to as scientific and technical personnel. The literature in some cases does not make a distinction among the different occupations and this study will occasionally cross occupations. The definition of an engineer used in this study approximates the definition used by the U. S. Department of Labor: that part of the labor force that has classified itself as an engineer or whose most recent employment has been in a firm-classified engineering position. This definition does not necessarily coincide with definitions employed by other studies or institutions. The emphasis is also on the manpower issues of unemployment and reemployment although it is recognized that the largest proportion of the engineering labor force is employed during any particular time period.

This study presents its recommendations in the first chapter. The following chapters examine the labor market experience of engineers from recruitment to layoff, job search and reemployment. Training and skill obsolescence is also discussed as well as national manpower programs to assist reemployment.

I. RECOMMENDATIONS

The following recommendations are a result of this study and are addressed to several parties, in alphabetical order, who are concerned with the labor market for engineers. No attempt has been made to place the recommendations in order of importance and in some cases the recommendations cut across interested groups. The chapters following this one present the evidence and experience upon which these recommendations are based as well as conclusions and additional specific recommendations.

Education

1. Support efforts towards a single, general undergraduate degree in engineering. This would allow for greater flexibility in the undergraduate program and in mid-career changes.
2. Stress skills and training that are transferable among tasks and occupations since there is transferability among engineering specialties and considerable advancement to supervision and administration. This would permit unemployed, mid-career engineers increased flexibility in administrative openings.
3. Increase cooperation with public and private agencies

and companies directed at mid-career programs and in-plant training.

4. Continue use of projections for institutional planning.

Employers

1. Adopt portable pension programs and early vesting in programs. This would reduce turnover and decrease mid-career recruiting costs.
2. Establish a stand-by program to aid the re-employment efforts of discharged engineers. This program to include publicity, facilities and furnishing of evaluations.
3. Encourage recruitment and transfer across specialties. There is evidence that engineering skills are transferable among engineering tasks.
4. Revise performance ratings and evaluations to reflect the contributions in administration and supervision.
5. Develop the capability and use of forecasts; particularly the relationship between engineering inputs and the final product.
6. Cooperate with public, local manpower agencies during changes in manpower requirements for training, recruitment and layoffs.
7. Support efforts for a single undergraduate degree.
8. Encourage transfer for mid-career engineers between

work sites and tasks.

9. Small, young or growing firms should consider the recruitment of mid-career engineers with administrative experience in addition to the use of internal promotion.

10. Consider recruitment of engineers from aerospace-defense firms whose former salaries and skill requirements are not different from civilian oriented firms.

Engineers

1. Non-degree engineers should gain the first undergraduate degree. This is particularly important for reemployment.

2. Continuing, formal education is most important for internal promotion and transfers. It is not a solution to prevention of layoffs or early reemployment.

3. Support efforts towards portable pension programs and early vesting in programs.

4. Increase professional and personal contacts during the career as an important aid in case of discharge.

Engineering Societies

1. Support efforts towards portable pension plans and early vesting of employers' contributions to equalize the employers' costs of recruitment of new graduates and layoff of mid-career personnel.

2. Support efforts towards a single, general undergraduate degree in engineering since there is already considerable transferability during employment.
3. Devote additional resources to the issues of mid-career employment and reemployment.

Public Officials

1. Use manpower projections in budget decisions. Year-to-year changes in federal priorities are small; however, they have a large employment effect on engineering.
2. Unemployment among engineers is not simply an aerospace-defense expenditures problem. Future manpower programs should not be confined to former aerospace-defense personnel nor to geographic areas of highest overall unemployment which do not usually coincide with areas of high engineering unemployment.
3. Encouragement of portable pension plans across companies and requirement for uniform, early vesting.
4. Require employers who receive contracts or subcontracts above a stated amount to prepare standby programs to aid the reemployment of discharged engineers. These programs to include publicity, use of facilities and the furnishing of evaluations.
5. Require evaluations of prior efforts and experience

during consideration of legislation concerning engineering manpower.

6. Federal contracts and priorities should provide for the longest feasible planning period. This is important for both the individual firm's manpower adjustment and to allow public manpower agencies to make commitments for employment and reemployment efforts.

Manpower Agencies

1. Programs addressed to engineering unemployment should not be limited by industry of prior employment.
2. During the innovation and evaluation of new programs, the results of prior research and demonstration projects should be employed. Where on-going programs are being considered for expansion or renewal summary data and progress reports should be requested and consulted.
3. Programs whose objective is reorientation to non-engineering related tasks are unsuccessful; however, programs where new tasks resemble previous engineering work are successful. Specific training is more successful than general training.
4. Local manpower agencies who are responsible for planning the use of revenue sharing funds should devote resources to the segmented labor market for engineers rather than depend on national treatment. The early

response of engineering unemployment to favorable general economic conditions inhibits the continuation of national efforts; engineering unemployment, however, may remain an important local issue.

5. Forecasting for engineering manpower has been concentrated at the national level. To increase the use of local resources the engineering forecasters should devote their attention to regional and local markets.

6. Demonstration projects that include labor market information systems should also explore the possibility of the continuation of the information system by transfer to an operating program, either public or private.

7. The success of placement after training or orientation is closely related to prior placement efforts. Contractors should emphasize pre-training placement. Efforts should also be made to provide for an employment history following training and for a rigorous evaluation.

8. Operating programs should establish an evaluation procedure at the outset.

9. Self-help and placement efforts should be encouraged. Continuity should be provided through a supported cadre. These groups also provide emotional support.

10. Use of personnel in job development from those industries and occupations in which job placements are sought should be encouraged.

11. The Bureau of Labor Statistics should continue its time-series on engineers and scientists and encourage all states to develop their own data. When the states have this capability the national series should be continued based on state data.

12. Any computer based job information system should include the capability to classify and report by experience which is important in the reemployment of mid-career engineers.

13. The National Registry for Engineers duplicated and competed poorly with the public Employment Service. Incentives should be established for cooperation between the alternative labor market information systems, i.e., credit should be provided for referrals.

14. A national registry cannot rely solely on direct applications. Provision should also be made for "feedback" on placements, referrals, status of orders and applicants.

15. Continuous time-series data on engineering employment should include breakdowns by geography, vacancies and engineering experience.

16. Use of individual training grants in engineering as subsidies for employment should be encouraged.

Researchers

1. Investigation of how firms make internal adjustments to changes in engineering manpower requirements.

2. Investigation of the application of engineering skills to non-engineering tasks.

3. Investigation of the job search process to include the clarification of alternative channels, the timing in their use and relative roles in placement.

II. AN OVERVIEW

Employment in Engineering

The engineer in his work and personal life style characterized the American dream of the post-war period and the expansion of the U. S. economy in the 1950's and the beginning of the 1960's. Engineers were white-collar professionals often employed in large technically oriented organizations which housed their employees in glass enclosed, air-conditioned sites. Many drove home in the evening to two-car garages to be surrounded by other glass walls and air conditioning. This style appeared to be everybody's goal and the direction in which the country was going. The dream, however, was altered for many Americans during the 1960's and the engineer has not been spared the difficulties of disillusion and reevaluation that has overtaken other groups in our society.

Engineers have suffered from cyclical unemployment for job opportunities for engineers depend both on the health of the general economy as well as national priorities. Engineers in our technical society are employed in many product and service areas with the highest concentration in construction (12 per cent) followed by aircraft and space (10 per cent). This dispersion of job opportunities means that engineers are affected by general downturns in the economy. At the same time the concentration in aircraft and space and related industries has meant that engineers are also affected by changes in federal expenditures for defense and space production, research and development. Forty-four per cent of the engineers in a 1971 survey reported that their jobs depended in part on federal funds.

When a general downturn in the economy coincides with a shift in national priorities the result is a lack of job opportunities for engineers. This happened in 1963-1964 and again in 1970-1971. In both periods changes in defense purchases were part of a larger national strategy to lower defense commitments or reduce inflationary pressures.

Our market-oriented economy concentrates most of its efforts in the production of goods and services and considerably less in research. This allocation of the nation's resources has meant that the largest proportion of engineers are employed in production and operations. Ranked on the basis of specialization engineers are in Civil, Mechanical, Electrical, Electronics and Aerospace.[1] These specializations,

[1]This ranking is from the 1971 NSF study based on a sample of the membership of the engineering societies. The 1970 Census reported that 34.4 per cent of the self-classified male engineers did not possess the first degree.

however, do not limit engineers and there is a considerable amount of crossing-over among specializations and tasks. Finally, the central importance of the large and complex organization to our economy has meant that many engineers move into management and administration during their careers.

American firms that employ engineers substitute among specializations and between skill levels. These substitutions are a response to short-term changes in manpower requirements and internal personnel practices. Companies would rather shift employees and their tasks around than pay the costs of recruitment or layoff. As a consequence, firms may substitute technicians for graduate engineers, inexperienced engineers for experienced personnel and technicians' talents for that of a graduate engineer. An NSF study reported that 11 per cent of the engineers held less than a Bachelor's degree.

Two separate labor markets for engineers exist side by side. One, the market for new college graduates who are recruited on the campuses and the other, the market for mid-career engineers who are recruited by operating personnel through direct application. Both of these markets went through a celebrity period after the first Russian space probes. The public was told that campus recruiting for top seniors in engineering equalled the recruitment for outstanding athletes and experienced engineers were said to be lured away from one company to another with lucrative offers. Expansion in engineering enrollments followed public opinion.

The engineering profession, unfortunately, became a victim, in some sense, of its own press releases. Lack of job opportunities for engineers in the middle of the 1960's and at the beginning of the 1970's left unemployed engineers bitter and disillusioned. They had come to believe that they were an important resource and that the most technically sophisticated country in the world needed their services for its continued growth. Engineers expected the federal government to step in and provide aid and jobs; this was particularly true in aerospace-defense. Unemployed mid-career engineers who had moved into supervision and administration found reemployment extremely difficult since companies prefer to promote to management positions from within the firm. The Engineers Joint Council in 1971 reported the average duration of unemployment as 30 weeks. This higher rate is contrasted with 14 weeks of unemployment reported nationally for all professional and managerial workers, many of whom are self-employed, in the same year.

When engineers went to look for jobs they sought work among their personal contacts in the immediate geographical area. In many cases this coincided with the preferences of firms to recruit through informal leads and in the immediate area; however, it also limited job search. Unemployed engineers, particularly those from aerospace-defense, found that prospective employers in other industries were reluctant to hire from outside their own industry. There was a strong feeling that aerospace-defense engineers were not cost-effective and were accustomed to cost-overruns and higher salaries. Engineering salaries, however, are roughly similar across product groups and within labor markets firms prefer to pay the going rate without getting too far out of line on salaries. The Engineers Joint Council reported that 55 per cent of all engineers in manufacturing in 1970 had an annual income between $10,800 and $16,800. This is similar to one report's $16,000 for mid-career engineers in aerospace-defense.

Finally, there was the matter of age and the problem of being over-the-hill. As the nation moved into the 1970's, many engineers who had recently faced manpower reductions in their departments and unemployment were wondering where the American dream had gone sour and if they weren't being traded in for a new foreign model.

The Literature

Theoretical Studies. The theoretical literature has concentrated on two issues, the shortage or surplus question and whether the labor market is similar to or different from labor markets for other occupations. Blank and Stigler (11) defined an engineering shortage as one which exists when, "...the number of workers available increases less rapidly than the number demanded at the salary level paid in the recent past...," and their shortage test consisted of a comparison of the earnings of engineers with the earnings of other professional groups and wage earners. They found that since 1929 engineering salaries have decreased substantially relative to all wage earners and to incomes of independent professional practitioners and concluded that no shortage had existed at least up to 1955. Arrow and Capron (4) accepted the principle that price increases occur in a shortage situation and devoted their attention to the dynamics of labor market adjustments which they felt were most important for engineers in the post-Korean period. They identified several factors which affect the size of the shortage and contended that the reactions of the engineering labor market were slower than other labor markets. Hansen (30) re-examined Blank and Stigler's (11) data and added two additional years. He concluded that for other than beginning engineers, market conditions had been one of surplus. In a later paper, (29) however, he concluded that employers viewed the future market as having a shortage. Finally, Folk (21) emphasized starting salaries and extended relative earnings to 1964. He concluded that employers of engineers are adverse to the bidding up of salaries and consequently salaries were a poor measure of the state of the labor market. With the use of vacancy data he concluded that excess demand in the middle and late 1950's tapered off in the 1960's.

The theoretical discussion of the labor market for engineers and scientists also concentrates on the question of whether the market is national in scope or whether there are a number of barriers to occupational and geographical movement. Folk (21) concluded that the market for new college graduates may be wide; however, the experienced engineer is less flexible and not mobile and faces a disorganized market. Myers (43) stated that the labor market for engineers and scientists is a number of sub-markets. Freeman (23) examines the effects of technology on scientists and engineers and their labor market. He states that from 1950 to 1960 the labor market strongly favored highly skilled workers; however, this changed from 1960 to 1968. His analysis is based on the assumption that scientific and engineering manpower is employed in a number of sub-markets which are related to where research activity is being undertaken and which firms employ young scientists and engineers trained in the latest techniques. Scherer (64), in an earlier effort, also focused on the relationship between innovations and the employment of scientists and engineers and concluded that those industries with a high employment of engineers and scientists were most likely to innovate.

Empirical Evidence. In the middle of the 1960's, prior to the Vietnam defense buildup, many defense contracts were cancelled or terminated and large numbers of engineers became unemployed. The Department of Labor (DOL) and the Arms Control and Disarmament Agency (ACDA) became concerned about the manpower effects of contract termination and cancellation and funded several labor market studies. The work of Bain, (5) Loomba, (38) Mooney (41) and Fishman (17) provide evidence from this period. At the end of the 1960's reductions in expenditures for defense and space programs again resulted in large-scale unemployment of engineers and the Department of Labor and the National Aeronautical and Space Agency (NASA) funded several labor market studies. The research of Allen, (1) Battelle, (6) Brown, (12) Thompson, (72) Turner and Whitaker (73) and Roderick (62) provide recent evidence.

The research methods of the individual layoff studies were an interview, usually by mail questionnaire, of a sample of laid-off engineers and scientists from an aerospace-defense plant. The questionnaires sought personal and economic data including: age, sex, marital and family status, education, income prior to layoff, duration of unemployment, methods of job search and reemployment experience. Analysis of the data often consisted of attempts to determine how the personal and skills characteristics of engineers and scientists affected their efforts to find work. Table 1 presents a listing of the

Table 1. Labor Market Studies

Study	Date[a]	Sample Size[b]	Company and Location of Layoff	Source of Data
Allen	1972	1,601	6 companies - S. Calif.	Mail Survey
Bain	1967	1,463	Hughes - Arizona	Mail Survey
Battelle	1971	2,519	21 plants, 7 companies: Bendix - Florida Boeing - South Chrysler - South Grumman - New York McDonnel Douglass - Calif. & Florida North American Rockwell - Calif. & Florida RCA - New Jersey	Mail Survey and Telephone
Brown[c]	1972	718	South, New York, California	Mail Survey and Telephone
Fishman, *et al.*[d]	1968	2,816 2,051 2,306	Boeing - Washington Martin - Colorado Republic - New York	Mail Survey and personal interview
Loomba	1967	733	Northern California	Mail Survey
Mooney	1965	320	8 companies - Mass.	Mail Survey
Roderick	1969		21 companies - national	Personal interviews and company records
Thompson	1972	480	8 companies - Mass., N.J., S. Calif., Wash.	Mail Survey and personal interview
Turner and Whitaker	1972	405	7 companies - Florida	Mail Survey

a Date of final report.
b Average number of responses to questionnaire.
c Data for this study was gathered by the Battelle study and supplementary data gathered by the Census Bureau.
d Data gathered by three previous studies for ACDA.

reemployment projects used in this study.[1]

At the beginning of the 1970's the Department of Labor also supported two demonstration projects, the Aerospace Employment Project (AEP), (40, 69, 70, 71, 86) and the American Institute of Aeronautics and Astronautics Employment Workshops (AIAA Employment Workshops), (3). Table 2 presents a listing of these two demonstration projects that provide further data.

Finally, federal funds supported two operating programs which provide further data on the labor market for engineers, the Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians (TMRP), (83, 84) and the National Registry for Engineers. TMRP included the Volunteer Engineers, Scientists and Technicians (VEST), the Skills Conversion Program (53) and the Technology Utilization Project (52). Table 3 presents a list of the operating programs used in this study.

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[1]Among the limitations on the use of this data is: the samples are not random, and it cannot be claimed that they are representative of the entire engineering population, samples are a proportion of the total laid-off at each plant, some studies included only engineers while others included engineers, scientists and technicians, the tasks of those in the sample covered a large number of skills and included research, development and production. Finally, the dates of the studies are different and labor market conditions in general and specific markets were dissimilar.

Table 2. Research and Demonstration Projects

Project	Date	Participants
Aerospace Employment Project (AEP)[a]	May 1971 - August 1972	371
American Institute of Aeronautics and Astronautics Employment Workshops	September 1970 -[b] December 1971	1,134[c]

a. Also funded by the U. S. Department of Housing and Urban Development.
b. Period of first demonstration project in twenty-two workshops.
c. Number who attended all sessions.

Table 3. Operating Programs

Program	Date	Participants
National Registry for Engineers (NRE)	November 1970 - June 1973	24,612[a] 6,102[b]
Skills Conversion Program[c]	July 1971 - March 1972	
Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians (TMRP)	April 1971 - August 1973	
Job Search Grants		4,864
Relocation Grants		2,027
Enrolled in Training		4,511
Placed in Employment by ES		12,224
Assisted in Employment by ES		21,698
Total Applicants Registered in Program		52,667
Technology Utilization Project (TUP)	April 1972 - August 1973	697
Volunteer Engineers, Scientists and Technicians (VEST)	June 1971 - April 1973	15,618

a. Total engineers and scientists
b. Total job orders
c. An effort to identify new job opportunities did not engage in training or placement.

III. MANPOWER ADJUSTMENTS BY THE FIRM

This chapter discusses how companies make adjustments in their engineering work force. Hiring new employees and laying off workers are only two ways that firms adjust. There is also a considerable amount of changing around of employees and tasks within companies.

Hiring

The manpower adjustments that companies make when they decide that they need more engineering talent depend, in part, on whether they consider their needs for a short time or over a longer period. Roderick (62) concluded after interviews and an examination of companies' hiring records that recruiters believe that hiring requirements are closely related to short-run changes in the profits of departments and really depended on the optimism or pessimism of the firm. Adjustments to increases in demand for engineers are, therefore, closely tied to the way the firm views its own immediate future rather than the industry or economy.

Forecasting by the firm plays an insignificant role in the firm's manpower adjustments. Roderick (62) found that forecasting techniques were ill-defined and displayed no particular pattern or trend within or between firms or industries. The original forecasting data came from the operating engineering departments of companies but it was used, if at all, by recruiters in the firm's personnel-industrial relations staff.

The firm may adjust to an increased need for engineers by any of the following:

1. Overtime for currently employed engineers
2. Improving the efficiency of currently employed engineers
3. Reduction or elimination of non-engineering jobs requiring engineering background
4. Redesign of engineering jobs to release engineers from non-engineering duties
5. Borrowing or transferring engineers from other locations or divisions within the company
6. Leaving vacancies unfilled and reducing production and/or research
7. Upgrading of personnel to engineering duties
8. Increases in the level of internal salaries to reduce quit rates
9. Increases in the level of salary offers to attract more hires
10. Reduction of the education, training, experience and other personal qualifications

11. Borrowing engineers from other companies

12. Subcontracting

13. Rental of engineers

14. Hiring at the entry level

15. Hiring at the experienced level

16. Intensification of recruiting efforts.

Some of these possibilities overlap; however, they can be divided into internal adjustments without new employment, possibilities one through eight, and new hiring, possibilities nine through sixteen.

Roderick's (62) conclusion that firms are most interested in their immediate, future needs explains why the principal employment adjustments reported by firms are internal, without new employment. He reports that firms are most likely to substitute inexperienced employees in tasks formerly carried out by experienced employees. Since recruitment and hiring take some time, the firm's first adjustments are internal. Internal adjustment is consistent with one of the major characteristics of the engineering labor market, the upgrading of non-degree technicians to engineering ranks and salaries. The incidence of this is supported by Allen (1) who reports that of the 241 aeronautical engineers surveyed, 43 per cent did not have a Bachelor's degree. Allen (1) also refers to a study by Holliman and Harger (27) who estimated that between 1950 and 1965 100,000 more engineers were created, presumably by upgrading and courses, than were available as graduates. Loomba (38) reported that 64.4 per cent of non-degree engineers in his survey began as upgraded technicians. The importance of upgrading is explained by the short-run view held by firms. Upgrading provides a quick source of labor and also provides the opportunity for firms to later demote or reduce their engineering talent if their short period forecasts should change. Firms also prefer to reduce qualifications, subcontract work or rent engineers from consulting firms. Folk (21) and Roderick (62) conclude that companies are much less likely to increase salary offers or their own internal salary structure. Salaries are tied to the external market, particularly at the entry level and firms express a desire not to get out of line by altering salary offers in the short period.

The recruitment of new and experienced engineers are separate activities of the labor market. In large firms central recruiting is conducted on campuses for entry positions usually as a trainee. Experienced engineers are lured by technical representatives of the operating departments. Recruitment on campuses for trainees may take place at the same time that the firm is laying off experienced engineers. The criteria given for entry level hires from the campuses by Roderick's (62) study are:

1. geographical considerations, is the school close to plant openings or central recruiting
2. the curriculum at the engineering school
3. past experience at the school, and
4. firm policies about where recruiting ought to be.

The geographical proximity of the schools and applicants to the jobs is important. Recruiting entails costs to the companies for the travel of recruiters and applicants and there is a feeling of greater certainty about nearby schools. Firms also engage in campus recruiting for prestige and publicity purposes as well as to meet specific requirements. Campus visits may be for information purposes rather than to fill a particular openings. Hiring under these circumstances would only occur for an outstanding graduate. These results indicate that even at the entry level the market is segmented.

In hiring experienced engineers firms indicate a strong preference for referrals. The use of referrals by friends and relatives is an initial screening device for recruitment. Preference is also given for an initial interview to those who can be brought in at little or no cost to the company. Interviews for distant applicants cost more. When distant applications are received by referral they have at least gone through an initial screening. This is further evidence that the engineering labor market is made up of a number of local markets. Recruiting facilities set up by firms with mass layoffs were also considered advantageous since they provided recruiters with prior evaluations for experienced hires. Direct application is also preferred to referrals from public and private employment agencies. Among the reasons given for not preferring employment agencies are that the agencies continually bother the firm, and the agencies do not engage in efficient screening but rather send "everybody." This preference by employers for direct application has important implications for the job search of unemployed engineers and is discussed in the next chapter.

The criteria for selection of experienced engineers in general order of importance are:

1. Experience and fit to the companies needs
2. Specific specialties
3. Interest in the firm
4. Degree specialty

Selection is based on a combination of general and specific criteria. Firms hire experienced engineers for a specific fit and seek an engineer with particular experience. Openings for experienced engineers listed with public and private employment agencies give detailed job requirements.

For entry jobs firms hire with general criteria in mind. The impact of technological changes on engineering tasks and the inability and unwillingness of firms to forecast future requirements confine recruiters to the hiring of new engineers on the basis of general criteria and what recruiters view as the applicant's long-term flexibility. In aerospace, the general preparation of electrical and mechanical engineering degrees is preferred to the aerospace specialty.

Layoffs

The adjustments that companies make when they decide that they require less engineering talent depends on the time period they are thinking about and the availability of engineers to the firm.

The firm could adjust to a decreased need for engineers by any of the following:

1. Redesign of engineering jobs to include non-engineering duties
2. Downgrading of tasks previously assigned to engineers
3. Elimination of overtime for currently employed engineers
4. Increase in education, training and experience and other personal qualifications
5. Decline in recruiting efforts at entry and

experienced levels

6. Increase in subcontracting and rental of engineers
7. Reductions in salary and/or level of responsibility
8. Layoffs and discharges.

The first efforts when less engineering talent is required are in the direction of internal adjustments: Reductions in salary and level of responsibility, transfers to other departments and plants, followed by a decline in recruiting for specific openings. The short period forecasts of firms and sudden changes in federal contracts cause firms that employ engineers to engage first in internal adjustments rather than discharges. This position is reinforced by the traditional view, held since the 1950's, that engineers are a scarce occupation. When short-run declines have been forecast firms have preferred to have slack in the use of an engineer's time and some downgrading of non-degree engineers. This is combined with a decline in recruiting efforts. Firms, however, even during a period of downward adjustment, will continue to engage in some public recruiting efforts on campuses and in the newspapers. This is done to maintain the image of the firm in the public and engineering community's eyes and to stockpile the resumes of potential employees against a possible future increase in employment requirements. Firms are also more likely to layoff, even during short-period declines, when they view the market as having a surplus of engineering talent.

Transfers to other departments and plants, however, also depend on the firm's overall business outlook and on the willingness of engineers to engage in reductions in salary, responsibility and to transfer. The Allen (1) and Loomba (38) studies indicate that engineers are often reluctant to accept a reduction in salary and/or level of responsibility. Engineers may prefer discharge where they can devote full time to job search and find new positions where they can match their salary prior to reduction. Engineers in multi-plant firms are also reluctant to accept transfer to other plants out of the area where a household move is required. Reluctance to accept downgrading or a transfer in aerospace-defense has been reinforced by the random pattern of federal contracts where new contracts are thought likely to occur in closeby firms or in the same company. Over a longer time period engineers' willingness to accept a reduction or transfer is also influenced by his perception of the job market.

Long-run forecasts of a change in production requirements prompt layoffs and discharges. Long-run in this market can be defined as a period that exceeds the average length of a major contract. Efficiency considerations predict that firms would retain their most productive workers as defined by performance and ability. The evidence based on discharges of large numbers of engineers and scientists is that the criteria for layoff depend on the reasons for the layoff rather than individual productivity or the state of the labor market. Allen (1) reported that when layoffs were associated with a particular project they were of all engineers, regardless of ability. This is supported by Thompson, (72) who found little difference between those who were laid off and those who were retained. Loomba (38) found that some of the firms in his study laid off across the board. There are some reported exceptions to this generalization. Allen (1) also found efforts to retain the most productive engineers and Loomba (38) concluded that some firms laid off those with no degrees or Bachelor's degrees first and that the aerospace-defense firms in San Francisco laid off based on seniority.

In the industrial model seniority is the principal criterion for layoffs and is often agreed to by contractual arrangements. In firms that employ large numbers of engineers and plants that emphasize production the industrial model was followed. Fishman (17) reported seniority as the basis for layoffs at Martin and Republic and contractual arrangements governed layoffs at Boeing, Douglas and RCA.

Finally, pension rights are often cited as a factor in the determination of layoffs. None of the research studies were addressed to this particular issue and there is no data on the role of pensions. The hypothesis has been advanced by engineers and their associations, however, that the closer an engineer is to vested rights in a pension the greater are his chances of layoffs and that firms save on labor costs in this manner by not contributing to retirement funds.

Conclusions

Manpower changes by firms that employ large numbers of engineers are governed by the immediate future outlook of the company. This future is often less than a year or the duration of a contract. The very short view used by companies is, in part, a response to the procurement policies and contracts situation in the aerospace-defense industry. Consequently, firms prefer to make internal manpower adjustments which can be effected quickly and at less cost than the employment of new personnel or the discharge of employees. Internal manpower adjustments to increases in demand consist of transferring engineers, subcontracting or upgrading technicians. When firms hire beginning engineers they often recruit from campuses. When they hire experienced personnel they prefer direct application or referrals. For both new and experience positions the geographical proximity of the applicant to the job is important in the initiation of the contact. The closer the applicant the more likely the initial interview. Hiring criteria are general for new recruits and specific for experienced engineers. For experienced hires the applicants' recent experience is more important than formal training. Internal manpower adjustment to decreases in demand often consist of transfers and downgrading. When firms lay off in large numbers they take into account the amount of engineering work to be done in a division and each engineer's seniority with the company. Firms, particularly those whose focus is production, are less likely to take individual productivity and performance into consideration in layoffs than those whose focus is research and development. Where there are large numbers of engineers in a department or division, seniority offers a widely recognized basis for personnel decisions.

IV. THE SEARCH FOR WORK

This chapter is concerned with the ways that unemployed engineers look for new jobs and how useful each of these methods is in finding employment. Methods of looking for work are usually categorized into formal and informal. Formal methods are those that have been set up specifically to assist workers and firms. These include The Public Employment Services, private employment agencies, Help Wanted advertisements and college campus recruiting. Informal methods are those channels whose objectives are not solely to assist employment. These include leads and referrals furnished by friends, relatives and fellow workers.

The literature on labor market information has often assumed that formal channels are the most efficient. This position is supported by the argument that formal sources can provide the most complete information about specific jobs to the widest possible number of potential employers and employees; further, formal channels screen applicants and cut down on wasted search time. There are also costs to looking for new employees or new jobs. For the employer these costs may include recruiters, newspaper ads and agency fees. For the unemployed worker these costs may include the time spent in search and agency fees. During search employers are looking for the most productive workers and workers for the best paying and most satisfying job.

Methods of Job Search

There are some obstacles to an assessment of the results of the research and demonstration (R&D) projects on the subject of job search. The studies often failed to clearly define and separate each form of search; for example, was direct application the first exposure to the firm or the result of earlier referrals and the last step in recruitment. Respondents to questionnaires also experience difficulty in recalling the several sources of job information employed. Within these limitations, the consensus of the R&D projects is that informal channels, particularly the use of friends and relatives, is used most often by unemployed engineers and is most likely to lead to reemployment. Mooney (41) reported that the major source of job information for professional engineers was the same as that for blue collar workers, friends and relatives, and that 25 per cent of this sample found their jobs in this way. This was supported by Bain, (5) who found that half of his sample indicated a preference for informal channels. Loomba (38) concluded that 30.5 per cent of the unemployed in his survey received their jobs through friends and relatives and Battelle (6) reported that 44 per cent of the respondents had used friends and relatives and found them "useful." Direct application is also the job search technique that often leads to reemployment and a great deal of success was reported by its use. Loomba (38) reported that most early offers were received in this way and Roderick (62) concluded that this was the most important source for experienced hires. Fishman (17) found that in Denver 45 per cent of the reemployed had found their jobs by direct applications.

The fact that unemployed engineers most often indicated that they had found new jobs through friends, relatives and direct application does not mean that they did not also look for work through formal methods. All of the studies that reported on how unemployed engineers looked for work found that employment agencies and newspaper advertisements were consulted. Mooney (41) reported that "formal sources of job information, Massachusetts Employment Security Office, professional associations, private employment agencies, newspaper advertisements, were sources of job information for just under 55 per cent of the sample." In a later study in another market, Allen (1) found extensive use of formal systems including special programs for engineers, scientists and technicians in California. Finally, newspaper ads were the second source of jobs likely to lead to reemployment.

The length of time that an engineer is unemployed has no relationship to the methods that are used to find work. Mooney (41) reported that private and public employment agencies and newspaper ads were consulted first; "Private employment agencies were consulted first as the most useful source of job information by 31 per cent of the sample." Loomba (38) found, however, that search began with direct application which was still important after 10 weeks of unemployment. After lengthy unemployment he found there was a shift to newspapers, friends and personal contacts. An explanation for the difference between the frequent use of formal methods and the lack of reported success when these methods were used lies in a consideration of employers' preferences. In the previous chapter it was concluded that employers prefer direct applications for experienced positions. They express the position that "good" applicants do not need public and private agency services. This attitude towards recruitment by companies has a direct influence on the outcome of job search by engineers. Engineers are aware of employers' attitudes and many avoid employment agencies. When agencies are consulted the leads furnished are often not successful and the unemployed turn to direct application, friends and relatives. Allen (1) concluded that poor placement results were obtained when formal channels were used and explained these poor results by the fact that engineers are often not aware of formal channels, particularly for use outside of the local labor market and for other occupations. He concludes that, "Informal systems are widely developed and accepted as the best method of finding new employment within the aerospace engineer labor market. These informal systems, however, break down outside the market and no satisfactory mechanism is developed to lead engineers into different types of employment. Rather than learning of job leads from generally recognized channels, job placement outside specialized labor market come through fortuitous happenstance."

One effort to give the engineer more information about job search was the American Institute of Aeronautics and Astronautics (AIAA) Employment Workshops. The genesis of these workshops began with groups of unemployed managers and administrators in the Los Angeles area. Among these groups were the Thursday 13 and Forty-Plus Club who sought to give their members assistance in job search techniques with the aid of local Employment Service offices. The AIAA Workshops began as a demonstration project in the Fall of 1971 and was expanded to eventually cover 175 employment workshops for 14,600 unemployed engineers, scientists and technicians in 43 cities. The workshop concept was eventually funded by TMRP until June 1973.

The approach of the workshops may be summarized as:

1. Engineers are used to steady employment at reasonably high salaries and they have very little idea how to find new jobs and obtain offers.

2. This aid is not generally forthcoming from the public Employment Service offices.

3. Each potential job requires a different approach, that is, the resume and interview should be tailored to the specific job and firm.

4. Peers who share the same experiences can provide the best counseling and assistance.

The workshops were voluntarily conducted and administered by the membership of a local AIAA organization or allied societies and consisted of three sessions, each two and a half to four hours long, spaced a week apart. The first session included: sources of job information, methods of finding employment and the need for self-evaluation. The second session included letter and resume writing and the third interview techniques.

The AIAA conducted an evaluation of 22 workshops in 11 cities attended by 1,134 unemployed engineers and scientists. In response to a survey taken at the conclusion of the workshops, 91 per cent thought that the workshops had been very valuable. Two months later a follow-up survey reported that of those who had found employment eighteen per cent said the workshops had been helpful in getting work and another 37 per cent thought that perhaps they'd been of some help. The change in attitude towards the workshops was probably due, in part, to the length of time elapsing between the workshop and the questionnaire and to the low reemployment rates being experienced two months after the sessions for only 22 per cent of the attendees had found new employment. The evaluation also established a control group about one-third the size of those who participated in the workshop; however, the characteristics of the two groups were not exactly comparable with regard to age, education or specialties. The control group, most of whom found work outside of aerospace, reported a higher proportion of reemployment, 27 per cent, as compared with 22 per cent for those who had attended the workshops, most of whom were reemployed in aerospace. An assessment of the direct results of the workshops is difficult; however, there was considerable participation by unemployed engineers in the workshops and an expression of interest in learning job search techniques. For those who attended, the workshops also provided a routine and focus to the unemployed engineers' days and a vehicle for discussion of their job search problems.

Conclusions

Unemployed engineers find their new jobs through direct application or leads furnished by friends and relatives. The reasons for this are that companies looking for engineers prefer to hire through these channels rather than agencies and engineers are unaware of the possibilities offered by formal methods. The single exception is newspaper advertisements which are often used. R&D results indicate that where formal methods are publicized such as special services offered by the U. S. Employment Service or a "job tent" set up by the former employer more engineers will use these methods. When they find that these channels do not result in job offers they become discouraged with the formal methods. Employers' hiring techniques and the unemployed engineers' search techniques, based on his close relationship with the community and other professionals in the area, serve to limit the usefulness of formal job information channels. These techniques also limit the engineers' search to the local labor market. There is little distinction between the engineers' job search and the manner in which other professional and blue collar occupations find jobs.

The reported preference of aerospace-defense firms for direct application and personal referrals is quite rational. The use of referrals is less costly to the firm than outside agencies and it also serves as a screening device. Friends and relatives may be more aware of the requirements for the particular job as well as the skills possessed by the applicant than an outside agency. This is particularly applicable for engineers in aerospace-defense industry where engineers and supervisors report that because of their mobility and the connection between prime and subcontractors they have gotten to know a large number of engineers in the field in their local labor market.

V. REEMPLOYMENT

In an article in the Monthly Labor Review Kathleen Naughton (54) summarized the characteristics of unemployed engineers at the beginning of the 1970's, "Among unemployed engineers, those formerly in aerospace work, regardless of their specialty, are having the most difficulty in finding suitable employment.... Older engineers and those with less than a Bachelor's degree also are experiencing hardships." The article also reported that engineers seemed to have remained unemployed for a longer period of time than most other professional workers. "Engineers surveyed by the EJC during June-July 1971 were unemployed an average of 30 weeks." This chapter examines the relationship between an engineer's personal characteristics, age and training, and his ability to find work. It also looks at how layoffs affect new salaries and where engineers are reemployed.

Age

R&D results consistently conclude that there is a positive relationship between age and the duration of unemployment. Or, the older an unemployed engineer is, the longer he is unemployed. Mooney (41) concluded that older engineers, those over 45, were unemployed longest as contrasted with those 34 years old and younger. He found that the average age of those unemployed 16 weeks or longer was 40 years old. Loomba (38) concluded that age was more important in affecting reemployment than the degrees held. Brown, (12) employing regression analysis, derived the following relationships between age and reemployment. "The probability of an engineer being unemployed increases approximately 8 per cent for every 10 years increase in age. This rate increase is more rapid for older engineers. For engineers approximately 40 years of age the probability of unemployment increase is 18 per cent for each 10 years increase in age." These findings are also supported by the studies of Battelle, (6) Allen (1) and Thompson (72). In the Battelle (6) data, those who were 50 years and older had the highest rates of unemployment (46.6%) followed by those 35 to 49 (31.9%), the 25-34 age group (19.2%) and the youngest group (18.4%). Allen (1) found the same relationship, 20 per cent of those between 45-49 were unemployed when contrasted with the age groups of 40-44 (17.7%), 35-39 (14.8%) and those 30-34 (19.6%). Finally, Thompson (72) found that those in the 41-45 bracket had the highest rates of unemployment (29.9%) and exceeded those over 45 years of age. In his sample the lowest unemployment rate was reported for those 26-30 who had a 12.2 per cent rate.

The relationship implied by the data from these studies is not exact; however, it can be generally concluded that the highest rates of unemployment are experienced by those in their mid-40's; the rate then declines and rises again in the 50's and 60's. The lowest unemployment rates are consistently experienced by the youngest age groups who are the first to be reemployed.

There are four possible explanations why older engineers are unemployed longest.

1. Age and salary go together. Older engineers generally receive higher salaries. Consequently, those who had received the higher salaries prior to their layoff have fewer new jobs at the same salaries open to them. They also have higher "aspiration" levels; they have been earning more and consequently seek those fewer jobs that pay more. Thompson's (72) findings support this when he says, "One gets a picture of the unemployed engineers as people who have been moderately high performers and who have looked for and are holding out for jobs in engineering rather than taking other possible employment." Sixteen per cent of those in the highest salary levels, $16,000-17,000 were still unemployed in the Thompson (72) sample. The opposite of the older worker's attitude would be those of the youngest engineers with the lowest percentage of unemployment. These workers can find more

openings at their previous salary level and they are quicker to lower their "aspiration" levels having more years to recapture any salary cuts received as a result of taking a new job at a lower salary.

2. Age and job assignments also go together. Older engineers are more likely to be in administration or sales related assignments. Consequently, their recent experience, which Loomba and Roderick found to be important in hiring experienced engineers, is not in those engineering related tasks where the openings are. At the same time firms prefer to promote supervisors from within their own companies.

3. All unemployed engineers do not hold degrees. Some have risen to their most recent job titles over the years through upgrading and reclassification in their companies. The high unemployment rates of those in their 40's may reflect the fact that many of the unemployed are upgraded technicians who are not regarded as engineers by other firms which require a degree. Loomba's (38) conclusions support this for he found that age, particularly for non-degree individuals, was most important in determining their period of unemployment.

4. The hiring practices of firms discriminate against older workers. Firms prefer to hire younger engineers at lower salaries without pension vesting. Loomba (38)

concluded that, "The hiring policies of employers appear to be discriminating towards older engineers and scientists, irrespective of their educational background, pre-layoff salaries, technical publications, patents, readership in technical magazines, and membership in professional societies. Older engineers remain unemployed for a much longer period of time."

Specialization

There is no consensus in the research with regard to the relationship between the area of engineering specialty and the length of unemployment. Loomba (38) found no relationship between the engineer's area of specialization and the length of time he remained unemployed. Allen (1) found, however, the least unemployment for electrical engineers compared with aeronautical, mechanical and industrial engineers.

Education

The important relationship between education and length of unemployment is between those who don't have the degree and those who have attained the Bachelor's degree. Engineers without the degree who are discharged have the greatest difficulty in finding new employment. This is supported by Mooney (41) and Allen (1) who found that those with Bachelor's degrees, as contrasted to those who had only 15 years of education and no Bachelor's degree, had considerably lower rates of unemployment. The difference was the degree. Again in Allen (1) it was also true at the Master's level. Those with 17 years of formal training without the Master's degree had higher rates of unemployment than those with the Master's. Beyond the Bachelor's degree, however, the evidence is mixed and the direction of the relationship less precise. Ph.D.'s in engineering, who are a small proportion of all engineers, suffer the least unemployment but there is some prejudice among employers against hiring engineers with considerable education. Allen (1) found that employer preferences appear to be against education beyond the Master's degree and that employers feel that such workers will not be satisfied with particular tasks.

Salaries

There is general agreement in the R&D findings on the effects of unemployment on salaries. Engineers who are reemployed in the same industry at their former tasks receive approximately the same salary that they had received prior to layoff. Mooney (41) reported that 81 per cent received either a salary increase or no change in salary. Brown (12) found that the average salary after layoff was 99 per cent of the salary prior to layoff. Most engineers, however, change industries and/or occupations and when they do they experience a reduction in salary. This is concluded by Fishman (16) and Allen (1). Thompson (72) found that those who stayed in engineering received 1.4 per cent less, while those who left took a reduction of 3.7 per cent. The industry that the engineer stayed in was also important. Thompson (72) concluded that those who remained in aerospace took less of a cut and Allen (1) found that aerospace engineers received $48.6 less a month while the average reduction, which includes those who left aerospace engineering, was $209 a month.

The theoretical work in economics concerned with the relationship between salary levels prior to layoff and the length of unemployment predicts that high salaries prior to layoff present the unemployed with high "aspiration" levels; however, over the course of unemployment the worker will lower his aspiration level. There is some support for this in the studies. Allen (1) reported that of those who rejected jobs, the largest proportion of these did so because "...salary was too low." Allen (1) also concluded that the lowest salaries were associated with the longest duration of unemployment. "After 26 weeks the probability of finding a very high paying job is greatly reduced while the number accepting very low paying jobs continues to increase." Brown (12) investigated the relationship between "aspiration level," or what he termed "asking salary" and a number of variables including age, months unemployed and difficulty in finding work. He concluded that age and difficulty in finding work were important and that the unemployed were willing to accept 85 per cent of their former salary.

<u>Where Engineers Find Jobs</u>

There is general agreement among the R&D results that slightly more than half of unemployed engineers find new jobs in engineering but in industries or firms that produce products different from their previous employers. Both Bain (5) and Brown (12) found that 53 per cent of the engineers surveyed stayed in the same occupation. Allen's (1) results support this conclusion. He found that the largest proportion of those reemployed (31.2 per cent) had found work in the same engineering field, followed by those who had found reemployment in an engineering field of limited experience (24.8 per cent).

The industry and occupation of new employment was also related to age and prior tasks. Thompson (72) found that the oldest workers made up the largest proportion of new, non-engineering jobs and Battelle concluded that those engineers in production tended to stay there, while of those who were in R&D only 50 per cent stayed in the same job functions. Engineers also are most often reemployed in different industries. Brown (12) concluded that 74 per cent were not reemployed in aerospace but in general manufacturing and Battelle (6) concluded that only 8 per cent went back to aerospace-defense while 25 per cent found jobs in general manufacturing.

The topic of where engineers find jobs is closely related to the subject of the mobility of engineers between industries, occupations and geographical areas. There are several types of mobility: industrial mobility is defined as a move out of the industry in which the engineer was previously employed, occupational mobility is defined as a move out of the previous occupation which was most often engineering-oriented and geographic mobility is defined as the movement of the household, usually reported as a move across state boundaries. Mobility is particularly important in a consideration of reemployment and there is considerable debate about the willingness of engineers to engage in geographic mobility. One position is that the geographic labor market for engineers is national and engineers demonstrate a greater willingness than blue collar workers and most professionals to move. The other position is that the market is segmented and engineers are as reluctant to move as other occupational groups. Policy and program decisions related to labor market information services depend upon the position taken on mobility. The data from the R&D

studies is related to actual moves rather than intentions or possibilities.

The consensus of the studies is:

1. Those who move are better educated, more skilled and somewhat younger than the average in the samples.
2. A large proportion of those who move receive higher salaries in the new jobs than they had received prior to layoff. Those who moved responded to clearly stated job offers and not to look for work.
3. Those who moved experienced the shortest periods of unemployment.

With regard to education, skill and age, the evidence is offered by Mooney (41) that the mobile group was slightly younger, higher salaried and somewhat more skilled, as measured by the mathematics index and number of science courses. This is supported by Turner and Whitaker (73) and by Battelle (6) which found that those with Master's degrees had the highest propensity to move, followed by Ph.D.'s and those with Bachelor's degrees. Blue collar, technical workers and non-degree holders indicated the lowest propensity to move in the studies by Bain (5) and Fishman (17). The low propensity to move by the least skilled was equalled only by the universal findings for women. Women, regardless of age, education or skill, were the most reluctant movers.

The traditional explanation given for this is that women are usually secondary sources of family income and their unemployment is unlikely to lead to a family move if they are married. Most of the women in the studies were employed in clerical or production work and very few in the professions and sciences. The mobility patterns of professional women who are single or the principal sources of family income could not be determined from the available data because they were not distinguished from male engineers. For a study of the job characteristics of women scientists and engineers see David (14).

With regard to geographic movement and salaries the evidence is offered by Mooney (41) that slightly over one-half of the mobile group received a salary increase and Loomba (38) reported that those who moved to other regions received relatively higher salaries than those who remained in California. One explanation for this conclusion is offered by the evidence that engineers indicated they required a salary differential to induce them to move and consequently all those who moved reported higher salaries. Thompson (72) found that the offered salary for a new job elsewhere had to be higher than the engineer had received prior to layoff for acceptance.

There are two possible explanations for the relationship between geographical mobility and the duration of unemployment. One is that unemployed engineers who are willing to move and who have an expanded view of their labor market are most likely to find jobs. The other is that engineers move only to a new job based on an actual offer and as a consequence all movers suffer less unemployment. The answer is somewhere between both explanations. Engineers who expand their market search receive new offers and have less unemployment. The consensus that those who move tend to be younger and better educated has to be qualified, for educational attainment has been increasing and as a consequence younger members of the labor force also have more years of formal training than older engineers.

There is some evidence that there are movers and stayers, or that those who have moved once will be more likely to consider moving again. Mooney (41) concluded that, "The most clearcut finding was that those engineers who had recently moved into the state, i.e., those who might have the highest mobility, say within the last six years, were the most likely to relocate." This statement is related to the labor market in the early 1960's in the Northeast and cannot be generalized to the 1970's for those who reside in the West, Southwest and Southeast.

A related issue with regard to geographic mobility is the role that area of present residence plays in affecting mobility. That is, are workers who reside in what could be considered more desirable areas less likely to move. One of the difficulties in answering this question is in defining a "desirable area." The literature indicates that engineers through the 1960's were less reluctant to leave the Northeast than they were to leave the West Coast. Loomba (38) found that most of the engineers in his survey, 85 per cent, sought reemployment in the San Francisco Bay area, 54 per cent in other parts of California, and the rest in the Pacific and Western part of the country. Bain (5) found that most of the laid-off workers remained in the Tucson area and of those who moved, almost all went to the West Coast.

Finally, home ownership has been considered for its effects on geographical mobility. Home ownership is closely related to age, salary and family size. For engineers home ownership retarded mobility. Loomba (38) and Mooney (41) both concluded that home ownership inhibited movement.

There is a general consensus concerned with the occupational and industrial mobility:

1. Engineers do not voluntarily leave jobs that require engineering skills.
2. Engineers do not experience an occupational barrier in moving from defense to commercial work.

3. When an engineer makes an occupational move it is most likely to be into sales and management.

Engineers leave engineering jobs reluctantly and often not voluntarily, see Folk (21). The principal reason for the reluctance to change occupations is that previous experience is an important determinant in the hiring of experienced engineers and in setting salaries as reported by Battelle, (6) Loomba (38) and Roderick (62). Dalton and Thompson (13) report that engineers' evaluations are closely tied to engineering tasks and performance in engineering. Consequently, the largest relative salary increases are closely associated with engineering work. Movement into sales is often a result of job search. Movement into management comes during the engineer's 40's, later in the engineers' careers and as an alternative to salary limitations. Folk (21) concludes that to enter sales is to virtually abandon engineering as a career. This is supported by Loomba (38) who found that of those who went into commercial work, the largest portion had not attained the Bachelor's degree.

The labor market studies also concluded that engineers have no difficulty in moving from defense to commercial work. Mooney (41) and Loomba (38) reported no disability in making the switch. The subject of skill and job conversion is discussed in the next chapter.

The Aerospace Employment Project (AEP) was a demonstration project addressed to the possibilities for the reemployment of engineers in the public sector. It was sponsored jointly by the Department of Labor and the Department of Housing and Urban Development and administered by the National League of Cities and the U. S. Conference of Mayors. The Department of Labor focused on the possibilities for the placement of unemployed engineers and scientists in government jobs with a minimum amount of orientation and the Department of Housing and Urban Development focused on the possibilities of using engineering skills to conduct local government activities, particularly in building the capacity of local government through the Model Cities program.

The principal objectives of the project were:

1. To determine whether professional manpower needs of state and local governments, particularly related to Model Cities capacity building, could be met effectively from the ranks of unemployed engineers and scientists from aerospace-defense.
2. To determine whether a brief reorientation and financial assistance for on-the-job training was necessary or adequate to aid reemployment.
3. To determine whether a central organization of state and local governments could develop an effective job

information network from the unemployed engineers and scientists to local governments.

4. To determine whether the skills of engineers and scientists in aerospace-defense could be useful to state and local government operations and management.

The job search and job information network was established between the umbrella organization in Washington, the National League of Cities and the U. S. Conference of Mayors and its local memberships in cities and counties across the country. This network was casual and consisted of job development through personal and letter contact between the League in Washington, D. C. and local governments. The objective of this contact was to inform local government of the professional talent available from the project and to encourage local government to hire graduates of this course. The League officials engaged in job matching and arranged for interviews. Finally, an informal job information network was established by the participants themselves who engaged in self-help, traded information and sought to place each other after the orientation program was over. The League attempted to formalize this network and encouraged about ten members of the program to organize other graduates of the program in their geographical areas into self-help groups.

The 30 day orientation programs were conducted in the summer of 1971 for 371 unemployed engineers and scientists at the Massachusetts Institute of Technology (40) and the University of California, Berkeley (86). Recruitment for this orientation was conducted through the media and with the aid of the State Employment Service offices. In California the State Human Resources Agency collected applications in the four districts that their Displaced Workers Program (DWP) (68) was operating in. The applicants were screened for their interest in working for local governments, willingness to transfer to the public sector and relocate, managerial experience and leadership ability. Thirty-eight per cent of those selected learned of AEP through the State Employment Service and the rest learned of the program through professional journals, Experience Unlimited, letters from the League and friends. The orientations were related to an understanding of the problems and processes of state and local government. Training, where it took place, was on-the-job (OJT) with employers eligible to receive a maximum of $1,000 to reimburse OJT costs.

The final report submitted by the National League of Cities/ United States Conference of Mayors (69, 70) in August, 1972 stated that of the 371 participants who had completed the orientation program in August 1971, 77 per cent found employment by April 30, 1972 and, of these, 65 per cent, 186 out of the 371, were in local government jobs and 35 per cent in private sector employment. Conclusions with regard to reemployment opportunities from the AEP demonstration project are:

1. The formal job development aspects of the project were too separated from the orientations. This created communication barriers between the participants and the administrators of the project.
2. The project was unable to provide, as originally planned, jobs prior to the orientation or by the end of the one month orientation. This made it difficult on the campuses to focus the orientation towards specific issues and created morale problems for the participants.
3. In order to successfully engage in job search and placement at the experienced level in public employment it is necessary to either waive or temporarily bypass civil service regulations. Civil service systems most often hire new employees from among local residents at the entry level and promote from within. The project was most successful in temporary public service placements under the Public Employment Program but had considerable difficulty in overcoming the barriers to permanent public employment. Top local government officials often indicated a willingness to cooperate with the League;

however, civil service regulations often provided a barrier. Those who engage in the actual hiring also resisted bypassing "normal channels."

4. Engineers and scientists who found jobs in local government often came from the same governmental jurisdiction; 70 per cent on the West Coast and 58 per cent on the East Coast. This can be explained by: civil service residency requirements, the general reluctance of the project participants to relocate and the importance of self-help in finding new jobs.
5. Probably more than half of the placements in the public sector were made by the participants themselves and informal contacts among the members of the program and their self-help techniques were important in job search and placement.
6. Most of the job openings in local governments are at the entry level at salaries considerably below those previously received by experienced engineers. This created a barrier for both employers and participants. Local government employers hesitated to make salary offers considerably below what the unemployed engineers had earned, partly in fear that they would later move. At entry levels, the engineers competed with younger college graduates

with degrees in Urban Planning and Public Sector Administration.

7. There was little indication that local governments sought to adapt the skills employed by engineers and scientists in aerospace-defense to government.
8. Less than half of the public employers requested the $1,000 grant for OJT.
9. New employment in the public sector was at salaries considerably less than in former employment; about $12,000 in government contrasted with $15,000 in aerospace.

The concurrence of the Emergency Employment Act (EEA) of 1971 with the Aerospace Employment Project affects the conclusions that can be drawn from this demonstration project. The Emergency Employment Act of 1971 was signed into law onJuly 12, 1971, after AEP had begun. The statutory purpose was "...to provide unemployed and underemployed persons with transitional employment and jobs providing needed public services during times of high unemployment and wherever possible in related training and manpower services to enable such persons to move into employment or training not supported under this Act." EEA provided funds which some local governments used for the employment of graduates of AEP and raises the unanswered question whether participants would have been hired without the concurrence of EEA. The

League's final report (69, 70) concluded that of all AEP graduates placed in the public sector, 50 per cent or 93 placements were supported by EEA funds used in jurisdictions with Model Cities programs. EEA placed a limitation of $12,000 on salaries and subsidized jobs were at about $11,000. In only a few cases did the employer supplement EEA funds with agency budgets to enable hiring at a higher skill and salary level.

Conclusions

Younger engineers are the first to find new jobs and the most likely to change their location. Engineers in their mid-40's are unemployed longest. They have received the highest salaries and want to keep these high salaries. Their most recent job experience has often not been directly in engineering tasks where there are most of the openings. Not having the Bachelor's degree is the biggest educational drawback and advanced degrees are less important in finding new work. Engineers look for the same work they have been doing in related firms in the same industry. Most unemployed engineers, however, find jobs in companies that produce different products. Staying in engineering in the same industry is important in maintenance of the same salary as prior to layoff. For those who find similar work in the same industry the salaries are about the same. For the majority, however, who move to other tasks and industries their new salary is considerably less.

Unemployed engineers are reluctant to move and move only when they have taken new jobs in another area. An important reason for this is that their personal contacts and direct applications are very useful in finding new jobs at the same salary. This is particularly true if they are located in an area, such as Southern California, where there are a large number of related firms. This behavior is perfectly consistent with the segmented labor market for engineers.

VI. TRAINING AND OBSOLESCENCE

This chapter examines the subject of the training and obsolescence of engineers. The principal issue is whether the training and experience of engineers is narrowly specialized or broadly based. The consequence of narrow specialization is that engineers cannot easily make the transfer out of the industry they have been employed in or into jobs that require non-engineering tasks. A consequence of wide application of skills is that with a small amount of retraining the skills of engineers may be useful in a variety of industries and tasks such as public services and the solving of environmental problems, transportation and urban problems. The three areas investigated in this chapter with regard to these issues are skill obsolescence, occupational and industrial mobility and formal training.

Skill Obsolescence

Two studies that examine skill obsolescence are by Paul H. Norgren (55) and Jean W. Dalton and Paul H. Thompson (13). Both studies conclude that creativity in engineering tends to come early in the engineers' careers, somewhere in the 30's. Norgren, (55) summarizing earlier research by Pelz (61), comments that creativity as a measure of professional accomplishment tends to reach a peak somewhere around the age of 35 and that the peak of creativity comes somewhat earlier for engineers and scientists engaged in pure research and later for those engaged in developmental research. Dalton and Thompson (13) point out that this relationship between creativity and age is carried into employment. Managers evaluate engineers based on this generalization of a peaking of creativity in the 30's and they conclude that performance rankings are closely related to age. Rankings rise until the early 30's, drop slightly in the late 30's, and fall steadily for each older group until retirement. The authors also conclude that this relationship has shifted downward with the highest performance ratings now occurring at an earlier age, in the 30's rather than in the employees' 40's. One possible effect of these performance ratings on employment may be that job openings and salary advances are most available in the 30's. This encourages and facilitates mobility in the 30's and reduces and inhibits it when an engineer reaches his 40's and 50's. Performance ratings could also lead to the earlier dismissal of the mature aged engineer and applied scientist; however, these implications are not entirely supported by the research. R&D findings discussed earlier concluded that layoffs are based on seniority rather than performance rankings. Norgren, (55) Loomba (38) and Thompson

(72) found no evidence that older engineers were laid off first.

Skills and Mobility

The consensus of the R&D studies on the subject of skills and mobility is that:

1. Very little training is required to make the transfer from engineering work in aerospace-defense work to commercial-civilian production. Rittenhouse (66) and Mooney (41) reported that of those engineers who had experienced transfers more than three out of five felt that defense-to-commercial transfers were about equal in difficulty to other kinds of transfers they had made. Only about 6 per cent felt that it wasn't very easy, or that it was very difficult to make the transfer. Twenty-three per cent of Mooney's (41) sample who had found jobs were reemployed in commercial production.

2. Managers were also optimistic about transferability from the point of view of skills and attitudes. Rittenhouse (66) reported that managers felt that while technical skill levels are regarded as higher in defense than commercial work cost-consciousness and production reliability is greater in civilian and consumer goods markets.

These conclusions are also supported by Loomba, (38) Eli Ginsberg (25) and the Technology Utilization Project (52).

Loomba (38) found that 54 per cent of those who went into commercial work appeared to make the shift without retraining. Ginsberg (25) said that engineers more than other occupations are noted for their transferability. In spite of these results the view persists that there are barriers to transferability. There are several possible explanations for a continuation of this view.

1. Performance evaluations inhibit mobility after the 30's. Salary increases for those in their 40's and 50's are in non-engineering tasks and these tend to keep engineers in the same industry or searching for jobs in the same industry.

2. There is widespread belief that salary levels are higher in aerospace-defense than commercial-civilian work. This inhibits job offers by civilian firms to engineers formerly in aerospace.

3. A number of "job-rated" engineers are technicians whose skills are less transferable out of firms and job-specific tasks in aerospace-defense than graduate engineers.

4. Transferability is greatest between "engineering-type" jobs. Engineers experience little difficulty in making the transfer from defense to civilian jobs when the new jobs are in engineering or related to engineering. There is considerably less evidence, however, of the easy transfer of more general skills, such as the "engineering" approach to

problem solving or a "systems management" approach.

What may be termed the "engineering" approach is that engineers have training and experience in "systems management" techniques which are applicable to a wide variety of tasks across industries. Further, that these techniques as practiced in the private-profit sector such as aerospace-defense can be transferred to the public non-profit sector. Some of the literature, however, is not in agreement with this "engineering" position. Ida Hoos (32, 33) in a critique of "systems management" concludes that it has gained acceptance and prestige beyong its accomplishments. Her review of public sector projects undertaken by the aerospace industry leads her to conclude that attempts to transfer the systems management used in aerospace-defense to other industries and tasks have failed. The author's position is based, in part, on the conclusion that engineers in aerospace operate in a very closely programmed non-inventive setting and that they work on a very specific task over time and are fitted to that particular task with few degrees of freedom. Self-starting, necessary in the non-defense sectors, may be a problem for engineers unless the work situation closely approximates the situation under which engineers have worked in aerospace.

Formal Training

The following conclusions can be made with regard to the formal training of engineers, when formal training is defined as continuous university courses, continuing education, and in-plant and on-the-job programs.

Engineering schools in the 1950's were encouraged by accreditation groups and professional reports to revise their curricula to include greater training in the basic sciences and mathematics. (26) The schools made these changes. Recent suggestions have included the need for training in the biological sciences, environmental topics and more flexibility in the curriculum. The last suggestion is prompted by the possibility that engineering graduates may move into other careers at graduation and by the desire to prepare students for changes in technology. Some schools have moved in this direction, treating environmental problems in their curriculum, allowing increased flexibility in course work among engineering disciplines and offering work in the social implications of technology.

Engineering schools in their teaching programs remain addressed to their undergraduate and graduate programs and have shown little interest in those issues of the labor market concerned with experienced engineers, mid-career changes and transferability.

Tuition refund programs are common among large firms. Norgren (55) found it in 36 of 39 companies. He concluded that most engineers and scientists were working towards Master's degrees or in non-credit university programs designed to update their knowledge and skills. Such efforts, however, do not affect the order of layoffs. While continuing education may affect internal promotion, there is no evidence from the R&D studies that it aids reemployment.

Formal training at institutions or in the plant provided the vehicle by which former technicians were upgraded to engineers.

In-plant programs were designed specifically to combat technical skill obsolescence.

On-the-job training is considered by engineers and researchers to be the most useful form for retraining and transfer. Both Rittenhouse (66) and Mooney (41) concluded that OJT is given a heavy preference by engineers followed by formal courses during working hours at the plant site.

Our discussion in this section has been confined to formal training. Further research needs to be done on informal training and experience in engineering for there is some evidence that experience is important in understanding the hiring and reemployment of engineers. Loomba (38) and Roderick (62) both conclude that prior experience was more important than formal training in the hiring of mid-career engineers.

Conclusions

The high performance ratings given to engineers and scientists in their 30's biases employment opportunities in favor of younger engineers. Increases in salary and prestige, however, do occur into the 40's and 50's. Engineers and their managers both agree that an easy transfer can be made by engineers from aerospace jobs to commercial work. This transfer is likely to be most successful when the new job is closely related to previous tasks.

VII. NATIONAL PROGRAMS TO AID REEMPLOYMENT

This chapter reviews national efforts to assist the reemployment of engineers. The major national program was the Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians (TMRP). TMRP provided funds for: the Volunteer Engineers, Scientists and Technicians (VEST), the Skills Conversion Project and the Technology Utilization Project (TUP). A smaller national effort was the National Registry for Engineers. Finally, Executive Orders 11598 and 11701, while not specifically addressed to engineers, have implications for their reemployment.

Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians (TMRP)

The Technology Mobilization and Reemployment Program (TMRP) was a national operating program administered by the U. S. Department of Labor, Manpower Administration through the U. S. Employment Service. TMRP ran from April 1971 to June 1973. The initial allocation was $42 million; however, the actual expenditures were less than half of the original allocation. The five aspects of the program were:

1. Job search
2. Job search grants

3. Relocation grants

4. Training, including on-the-job and institutional training

5. Skills conversion studies and training programs.

The genesis of TMRP was the State of California's Displaced Workers Program (DWP) (59, 68). This program aided by federal funds was in operation in four counties in the State of California from November 1970 to March 1973. Its objective was to find jobs for workers from all occupations displaced from the aerospace industry in Santa Clara, Los Angeles, Orange and San Diego counties. DWP was the general activity for the manpower monies and resources available in these counties where the Employment Service and MDTA funds were used for job search, training and relocation assistance. TMRP was also directed towards geographical areas with considerable unemployment of engineers, scientists and technicians (EST's). The program was administered through 23 Engineers, Scientists and Technicians Job Development Units (EST units) established in 23 state employment offices in geographical areas of large EST unemployment. In those states without EST units a staff member of the Employment Service was designated as the EST State specialist. The principal functions of the units and State specialists were to administer the funds and the programs and to act as specialists whose principal tasks were to aid in the reemployment of EST's. Information on the aid available through TMRP was not limited to those offices that had EST units. All local state employment offices were to be furnished with information on the program and the reemployment aids available through the program as well as applications for such aid. The extent to which local offices without EST units appraised eligible applicants of the program cannot be determined. The State of California had the largest unit and approximately 70 staff members worked in the program in that state at one time or another.

One unique feature of this program was the nature of its staff. The staff came from two sources, permanent civil service graded employees who were part of the State Employment Service assigned to TMRP and temporary, non-graded staff members who were employed specifically for the EST units. The distinction between the two types of staff is important for the temporary staff members were drawn from the ranks of former aerospace-defense employees and hired specifically for their knowledge and contacts in the industry. TMRP had State Employment Service personnel with direct work experience and contacts in the same industry from which the applicants came and towards which most of the job search was addressed. These staff members had been employed either in administration, sometimes the employment function, or as engineers. The civil service system had to be temporarily bypassed in order to employ these consultants. In the State of California authorization had to be received to hire unemployed personnel above the entry level and at salaries higher than the normal starting rates. TMRP and the State Employment Service appear to have overcome the civil service barriers in this program. There was considerable turnover among those from the industry. The temporary staff members drawn from the industry had the task of job development and this placed them in close contact with potential employers who often offered them jobs.

In addition to job development and placement the EST units also encouraged three types of training:

1. institutional training and training allowances
2. on-the-job training
3. on-the-job training coupled with institutional training.

Institutional training and allowances under the program were the same as other MDTA programs. Program approval was required by the State Employment Service and Vocational Educational Agencies for programs administered by institutes of higher education and technical schools. EST's and employers were encouraged to engage in single participant OJT programs and non-productive time could be reimbursed up to a maximum of $2000. Data on training, through May 1973, indicates that 4,081 EST's had engaged in training. The possibility that an EST applicant could provide a subsidy to the employer under TMRP may have increased the likelihood of an initial interview and eventual hiring for the data indicates, see Table 3, that more EST's carried training authorizations to their employers than were actually enrolled in training.

The following conclusions may be drawn about the program based upon data furnished by the EST units and state specialists from April 1971 through May 1973.

1. Applications for the program were cyclical. Applicants were high at the start of the program, then declined late in 1971. There was an increase early in 1972 and a decline in applicants in the fall of 1972.

2. It took some time for the program to result in placements. The largest number of placements occurred from early 1972 to the fall of 1972.

3. An increase in applicants in early 1972 was accompanied by an increase in relocation grants, placements, enrollments in training and job search grants. The program appeared responsive to increased needs. In the fall of 1972 when there was a large increase in registrants it was also

accompanied by an increase in trainees and placements.

4. There was a decline in the average salary of placements as a result of new employment. See Table 4. Based on the general conclusion drawn from the labor market studies it appears that most applicants found employment in new industries and tasks.

5. The program confined eligibility to EST's who had been employed in one of the three occupational categories "...for at least 12 out of the last 24 months by aerospace or defense companies whose business...was derived largely (at least 40 per cent) from defense or aerospace and which have had employment cutbacks due to contract reduction, cancellations, termination, etc." This was later broadened and included those who "...had substantial attachment of 24 months or more within the last five years in aerospace or defense...." (83) This definition excluded many unemployed EST's who had not had one or two years of attachment to the aerospace industry, particularly new entrants to the industry and younger members of the labor force.

6. The program was administered in 38 states through State EST specialists who decided where in the State the funds would be allocated without clear criteria.

7. In California at the outset, the program was confined to the same four counties as the Displaced Workers

Table 4. Distribution of Pre- and Post-
Unemployment Salaries of TMRP Applicants

Salary Range	Pre-Layoff	Post-Layoff
$25,000 and over	1.3%	.2%
20,000 - 24,999	6.2	1.3
15,000 - 19,999	25.9	11.6
10,000 - 14,999	47.8	45.4
Under 10,000	18.8	41.5
Total	100.0	100.0

Source: U. S. Department of Labor, Manpower Administration, TMRP Summary of Program Activity, April 19, 1971 - February 28, 1973, April 28, 1973 (unpublished, Washington, D. C.).

Program and some effort had to be exercised to broaden the geographical scope of the program.

8. The use by the State Employment Service offices of former employees of the aerospace-defense industry in job search serves as a model for job development and placement addressed to other occupations. It is also a counter-argument to the often voiced criticism that the Employment Service is unfamiliar with the needs of white collar and professional manpower. The Employment Service was able to overcome temporary hiring barriers.

9. The high turnover of the temporary personnel prevented the development of experience and continuity among the job developers and their employer contacts, while it demonstrated the usefulness of this approach.

10. No system for evaluation of TMRP was devised at the outset of the program, although a system of data keeping and reporting was established early in the program. This makes final evaluation of this program difficult. For example, placements by referral from Employment Service Offices, EST units and self-help organizations housed in the U. S. Employment Service offices should be disaggregated.

11. With regard to benefit/costs the following observations may be made about particular programs.

a. There were considerable differences among regions in the cost per participant for job search grants. The national average expenditure was $135.00.

b. Relocation grants per participant were quite similar across regions and the national average was $618.83.

c. The costs of OJT differed considerably across regions and the national average expenditure was $1,188.47 per trainee. This is explained, in part, by the considerable dispersion among regions for institutional training, where the national average was $1,809.57 and for OJT coupled, single and institutional. Some regions did not give OJT coupled grants and the national average was $659.82 per trainee.

A more complete evaluation of the benefits/costs of TMRP should include a comparison of costs with other training programs, reemployment results and subsequent salaries and considerations of alternative uses of the funds.

<u>Volunteer Engineers, Scientists and Technicians (VEST)</u>

VEST was part of TMRP and administered by AIAA. VEST engaged in job development, placement and training in job search techniques. The origin of VEST was also the State of California. During the 1960's a number of self-help groups, the Third Thursday group and later Experience Unlimited, composed of administrative, managerial and professional workers, were sponsored by the California Department of Employment (later, California Department of Human Resources Development). Engineers, scientists and technicians joined these groups at the end of the 1960's and they served as the model for the program funded by the Department of Labor and administered by the AIAA with TMRP funds. Local VEST chapters were established with the assistance of public Employment Service offices which furnished facilities, clerical support and funds for small expenses.

The VEST chapters were volunteer groups with their own name and internal organization which absorbed the AIAA employment workshops. Manpower was supplied by the active members who were required to work a stated number of hours each week for the unit. Each VEST chapter operated independently of the Employment Service (ES). It developed its own jobs and engaged in its own placement activity. There was, however, considerable cooperation. Some of the jobs developed were forwarded to State Employment Service offices, others were sent to the National Registry for Engineers (NRE). Job placements were not always reported to the ES which is required to confirm its own placements. As a consequence of this independence the summary data for TMRP (84) reports 11,538 EST's placed in employment by ES under TMRP and 19,952 EST's who found their own employment but were assisted by ES. It is assumed that the difference can be explained, in part, by the work of the VEST chapters.

The following conclusions may be drawn about the VEST program.

1. Thirty-two chapters operated between June 1971 and February 1973 and reported 8,715 members returned to employment.

2. Self-help eemployment effort on this national scale was unique among occupations and was spurred by the idea that professional occupations could aid themselves in finding new work.

3. Because of their voluntary and temporary nature, chapter efforts were sporadic. Cooperation and assistance from the State Employment Service offices and the AIAA was often important to the continuation of chapter activities.

4. A considerable part of the benefits of the VEST program cannot be measured solely in the traditional labor market terms such as jobs developed and unemployed placed. The availability of a structured peer group provided emotional support to the unemployed.

Skills Conversion Project

The Skills Conversion Project was funded by TMRP and administered by the National Society of Professional Engineers (NSPE). Its objectives were to survey the technology, products and manpower requirements of a number of industries to determine:

1. Which industries offered the greatest possibilities for the reemployment of engineers following retraining,

2. What the skill requirements of these industries were, and

3. The type of training that would be required.

The organization and implementation of the project reflects the aerospace orientation of its participants. Teams were used beginning with pilot teams then training managers and finally volunteer project teams. Volunteers were recruited through the State Employment Service and employment workshops. Leaders were compensated on a full-time basis and team members were paid on a daily basis. Volunteers were offered assistance in job search techniques as well as recent work experience for their resumes. Research was conducted and reports prepared for 16 industries: (53) food products and food services, health care and health services, transportation and traffic, forest operations and wood products, power resources, pollution control, thermal, air and water, security systems and criminal justice, ocean engineering and oceanography, banking, finance and insurance, leisure time and recreation, solid waste management, petroleum and chemical, educational technology, public services, occupational safety and health, mineral extraction. Each industry report (53) summarized the industry's products, technology, skilled tasks by occupation and forecasts of its employment. The quality of the reports are uneven. Some are extremely thorough and present a unique narrative of an industry's production process as well as a thorough catalog of skill requirements. Such a description of skill requirements for an industry is not usually available and these reports represent one of the few public attempts that have been made to describe occupational tasks. Other reports are superficial and could not be easily implemented for a training program. The forecasting sections of the reports have the greatest shortcomings. They often reproduced limited data from other sources. The unevenness of the reports reflects the voluntary nature of the project and the teams, the differences in skill among team members, and the differences in the time allotted to each industry by the team.

Technology Utilization Project (TUP)

TUP (52) was a series of training programs administered by NSPE as a result of the recommendations of the Skills Conversion Project. The components of TUP were similar to other federally funded training programs and included: applicant selection, training, job development and placement efforts. Twenty-four institutional training programs were conducted on campuses, particularly on the East and West Coasts. Most of the participants were selected with the assistance of the State Employment Service offices in the area of the program. The principal screening criteria were willingness to undergo training and to relocate. Job development included mail campaigns and presentations by NSPE staff to prospective employers. Firms were encouraged to interview participants before the program or during the four to twelve week programs.

The following conclusions can be made concerning TUP.

1. The program had the characteristics of a demonstration or pilot project with a limited number of geographic areas and participants.

2. Almost all those selected for the programs completed the training.

3. Placement rates differed among programs. Fifty per cent or more of the trainees found employment within four weeks of the program and a summary of the project (52) reports a 99 per cent reemployment rate.

4. Reemployment was not always in the industry in which training was received. The summary (52) reports 20 per cent returned to aerospace, 21 per cent in other fields and 59 per cent found employment in the reoriented field.

5. The success of job development and placement efforts differed among programs. In most programs placements were not accomplished before or during training. Programs with the highest placement rates in the industry of retraining were

those where placement occurred prior to or during the course. Special efforts were made to place trainees prior to training and the greatest success in placement occurred in those cases where the trainee was employed prior to the start of the program. Here the prospect of the training program enhanced employability.

6. The most successful programs, as measured by placement in the industry of retraining, were those in which the new jobs closely resembled previous work experience of the unemployed engineers and where the industry traditionally employed engineers. That is, retraining into power engineering was more successful than food or medical engineering. The experience of the first eleven programs narrowed the industries of training in the thirteen programs that followed it to: construction, power, traffic and transportation.

7. New jobs were most often located in the same geographic area as the training institution or the home of the participants. Although the trainees had been screened for a willingness to relocate they displayed an unwillingness to move after training.

The National Registry for Engineers

The National Registry for Engineers was a computer based job bank system which operated from November 1970 to June of 1973. It serviced an extremely small proportion of the labor market for engineers, scientists and technicians during that period, see Table 3. The Registry was set up in Sacramento, California and administered by the State of California Department of Human Resources. California was chosen for two reasons. First, its geographical proximity in the West to a large proportion of the potential users of the registry both unemployed engineers, scientists and technicians and prospective employers. Second, the State of California Employment Service had prior experience with a computerized labor market information system. This system, LINCS, had been planned and administered with federal funds in the 1960's as a part of the Department of Labor's continued investigation of the application of computer systems to facilitate job search. The techniques of LINCS were transferred to the National Registry for Engineers along with some of the personnel. The National Registry employed the following procedures. For the unemployed EST knowledge of the National Registry was transmitted to him through State Employment Service offices, engineering self-help programs, trade and professional publications, and newspaper and television advertisements. Placement in the job bank was accomplished by the completion and mailing to Sacramento of a registration form which was available either by direct application to Sacramento or from the employment service or self-help programs. The major sections of the application form included:

1. name, address, age and marital status
2. type of work preferred
3. minimum acceptable monthly salary
4. geographic preferences
5. education and training
6. work experience

This form was coded in Sacramento based on a vocabulary established for the LINCS system.

Companies learned of the National Registry through the same sources as EST's. They could register job orders directly with Sacramento, either by mail or telephone. The major sections of the job order included:

1. name and address
2. job title and location
3. salary information
4. job description.

The job order was then also coded on the LINCS vocabulary. The software work, coding and referrals were conducted in the National Registry offices several blocks from the job bank housed in computer facilities in the Department of Human Resources. Input and output were transmitted by messenger. Administrators of the Registry report that by setting general qualifications for a job order at a minimum the employer initially received about eight applicants for each job order.

Additional job applicants in smaller numbers were later sent to the employer as a result of additional passes through the bank and new applicants. Employers were encouraged but not required to respond to the matchups. They received followups which included a second list of the applicants and requested information on the employer's decision with regard to the applicant and the status of the job order. Sixty per cent of the employers were estimated to have responded to inquiries. No system was established to solicit feedback information from the applicants as to their experience with the registry and most registrants did not volunteer this information.

Some data on the use of the registry by EST's is available from a summary of those in the system in April 1973 (67) and a one-time questionnaire of applicants. The summary data is for only those applicants listed in the registry on that date and is broken down by: occupational title, veteran/non-veteran, age, education and previous income. The data indicates that of the 9,571 registrants on that date, the largest proportion were 44 years of age or younger, held a Bachelor's degree and had earned between $1100 and $1399 a month prior to their layoff. With regard to their skills, the largest number of engineers were classified as electrical/electronic and in the sciences the largest number were in chemistry. Summary data for 11 states reports the largest number of registrants were in

California (2,878) followed by New York (870) and Washington (604).

An evaluation of the usefulness of the Registry by EST's can be made, in part, by a determination of how representative the applicants were of all engineers and scientists and of unemployed engineers and scientists as of the same date, April, 1973. Such a comparison is not possible because of the lack of comparable data for the same date. Some generalizations are possible, however, with the use of the 1971 sample data on employed engineers reported by the National Science Foundation (51). Seventy-four per cent of the Registry applicants were engineers. The following can be concluded from a comparison of the Registry data with the NSF data:

1. The Registry was representative with regard to age. The Registry reported 56 per cent were 44 years or younger and the NSF data 55 per cent.

2. The Registry was representative with regard to education. The Registry reported 54 per cent held the Bachelor's degree and the NSF data 55 per cent.

3. A comparison of salaries could not be made since the NSF study did not report salaries.

4. The Registry applicants were representative of aerospace engineers, 7 per cent were reported by the Registry and 8 per cent by the NSF data and slightly over-representative of

electrical engineers, 20 per cent contrasted with 17 per cent, and mechanical engineers, 19 per cent contrasted with 10 per cent.

Responses by 904 EST's to a questionnaire from the Registry also provide some information on the usefulness of the Registry. When asked how they received their job only ten said they had received it through the Registry and 67 indicated aid from the State Employment Service offices. Administrators of the Registry indicate that it serviced a total of about 24,612 applicants from the unemployed and about 6,102 job orders from employers.

The following conclusions can be drawn about the National Registry for Engineers. The Registry served a very small but representative proportion of the total EST's unemployed at any single time. The orders reported probably represent a very small fraction of the total openings for EST's during the time the Registry was in operation. Applicants reported above average mobility (469 out of 904) and this is probably due to the fact that applicants to the national system had already seriously considered moving and exhausted local search. The Registry was quickly conceived and served only as a small addition to individual job search.

The use of this computer-based job information system had several limitations. The applicant's record of training and experience was limited by the ability of the coder, evaluation of his form and the size and language of the program employed.

His selection for orders was also limited by his initial statement, coding and the program's classification. The modified program, initially written for LINCS, was less applicable to the special aspects of the national labor market for EST's than it had been for the labor market in California. A new program should have been written to fit the job search for EST's. The employer's job orders were also limited by his initial job description and its coding and the program's classifications. Job matching was confined to those variables written into the LINCS program. For example, the program did not have the ability to screen on geographic residence. Employers were given qualifications without regard to either the employer's or job applicant's location. In the discussion of hiring practices in Chapter III it was concluded that the applicant's location was important to the employer's willingness to interview. Receipt of applicants' forms from across the country did make the employer reluctant to reuse the Registry. Finally, the Registry did not establish a system of evaluation from either side of the labor market in order to understand where it was most effective and where it was deficient.

Executive Orders 11598 and 11701

Presidential Executive Orders 11598 and 11701 were specifically addressed to the reemployment problems of Vietnam veterans; however, because of their general nature they have implications for the reemployment of engineers. The Orders require contractors and subcontractors who receive $2,500 or more of Federal funds to report their job openings with the Public Employment Service Offices. (Note: State and local government jurisdictions are also required to do so.) Contractors in aerospace-defense complied and listings in the State Employment Service offices for jobs in aerospace and defense increased after the signing of the first Executive Order. There is no evidence, however, that the Order has facilitated the reemployment of engineers. Rather, comments have been made that contractors prefer direct application, or even referrals from private employment agencies to a referral from the Employment Service. These comments are supported by Allen (1) and Roderick (62) who conclude that employers avoid agency referrals and view agency applicants as inferior to direct application.

VIII. CONCLUSIONS

This study has examined the labor market for engineers and public efforts to aid their reemployment. The Office of Research and Development (DOL) efforts have demonstrated a response to the public's concern over engineering unemployment, particularly in the middle of the 1960's and the beginning of the 1970's.

The research and demonstration projects that have been synthesized concentrated their attention on mid-career engineers formerly employed in large companies usually in aerospace-defense. This has also been true for operating programs. Public efforts to aid reemployment have been in two directions: one, direct aid in job placement and two, reorientation and retraining into new industries and new occupations.

There is a distinct tendency for national attention and public projects that respond to this attention to be preoccupied with the relatively large layoffs in the aerospace-defense firms which are supported by federal funds. Reductions in the national unemployment statistics for engineers usually serves to shift resources to other areas of concern. This often means that local agencies tend to view solutions to engineers' unemployment as a national problem and hesitate to commit local resources even when unemployment continues to exist within segmented labor markets. A shift in public priorities and goals to local labor markets is recommended particularly for a peace-time economy oriented towards civilian goods.

APPENDIX

A. Forecasting the Demand and Supply of Engineers and Scientists

Manpower forecasts may be used either as a tool for long-term public planning or to allow private decision makers to make more rational decisions. In its first use public economic and social goals are first stated and then forecasts are made of the manpower necessary to achieve these public goals. Educational institutions may direct their courses and enrollments towards these goals. In its second use descriptive projections are made based on the probable directions of the product and labor markets. Forecasting is often advocated because of its promises of allocation and efficiency. It affords a vehicle for either avoiding or minimizing shortages and surpluses. At the very least, it may provide a warning of serious imbalances towards which manpower programs may be addressed.

In the United States forecasting is of the second type (39). There exists neither a central forecasting agency nor generally accepted national goals towards which sources of labor supply such as educational and training institutions can set their programs. Forecasting is decentralized and engaged in by both public and private agencies.

Three generalizations can be made about manpower projections in the United States: first, there is a similarity in techniques, second, a similar set of alternative national, economic and social goals are used as assumptions for forecasting at the national level, and third, considerable attention is given to the implications of federal expenditures on the public and private employment of engineers and scientists. This appendix reviews the principal techniques used to forecast the demand and supply of engineers and scientists, the forecasts that are available and the current use of these forecasts and, finally, draws some conclusions and recommendations.

Forecasting Techniques

Three principal techniques have been employed to forecast the demand for and supply of engineers and scientists. These three techniques are: input-output analysis, regression analysis and the use of federal contractual obligations.

Input-Output Analysis. Input-output analysis, or the interindustry transactions approach, consists of manipulating a tabular model of the economy, which lists the transactions among all producing industries and between them and the final demand sectors. The first uses of this approach for forecasting engineers and scientists were made at the beginning of the 1960's when a number of private studies sought to predict the effects of disarmament on employment. Characteristics of these studies is the work of W. Leontieff and M. Hoffenberg (35) and the work reported in a volume by E. Benoit and K. Boulding. (7)

These studies forecast changes in employment as a result of a decline in defense expenditures. They were in the form of changes in man-hour requirements by industry and did not report employment by occupational classification. A second group of studies published at about the same time were motivated by changing defense requirements rather than partial or general disarmament. The input-output technique was again used and this work was aided by the publication of the U. S. Department of Commerce, Office of Business Economics, Input-Output Structure of the U. S. Economy: 1958. (75) Characteristics of these studies were the work of Max A. Rutzick, "Worker Skills in Current Defense Employment," (63) and Richard P. Oliver, "Employment Effect of Defense Expenditures." (58)

A shortcoming of the earlier forecasts was their failure to provide occupational projections. This was overcome by the development of the BLS matrix of occupational patterns which gives the per cent of total industry employment found in each occupation for 164 industries covering 185 occupations. This matrix is based on the industrial classification used in the 1960 census. Recent examples of studies that have used the input-output technique to project employment effects of government expenditures are the articles by Richard Dempsey and Douglas Schmude, "Occupational Impact of Defense Expenditures," (15) and Richard P. Oliver, "Employment Effects of Reduced

Defense Spending." (56) Both studies present estimates of defense-generated employment in private and government industry by major occupational groups and civilian employment attributable to defense expenditures by occupation for selected fiscal years from 1965 to 1971.

Two criticisms of the inter-industry transactions approach for forecasting are that the coefficients in the industry and employment matrices are based upon past relationships and that this technique is considerably removed from the actual labor market. Attempts have been made to overcome these criticisms. The industry matrix of the Office of Business and Economics has been updated to 1967 and the Bureau of Labor Statistics Inter-industry Growth Project has sought to update the manpower coefficients to more accurately predict actual employment. An attempt is under way, aided by field work, to obtain a better understanding of the manner in which private firms make employment adjustments to federal requirements. That is, are workers laid off, downgraded, or shifted to other tasks or plants.

Regression Analysis. The regression analysis approach predicts manpower requirements by the use of a model which contains some of the economic parameters which affect manpower requirements. It is not necessary that the model contain all of the parameters. These parameters have included gross national product, labor force and unemployment. The level of economic activity may be translated into total employment requirements and employment by industry. Employment by industry is then broken down into occupational manpower requirements. Representative of the use of this technique is the work conducted by the U. S. Department of Labor, Bureau of Labor Statistics (BLS).

Recent forecasting efforts have sought to combine elements of both input-output and regression. The Bureau of Labor Statistics combined them in the following manner. The level of economic activity and real GNP in 1980 were estimated by combining projections of the total employment with projections of hours of work and output per man-hour. Separate projections of these two variables were made for the public and private sectors of the economy. Once the basic economic variables for 1980 were fixed, detailed industry employment was estimated. Three methods were used, depending upon the data available, the level of industry detail required and the characteristics of the industry. One method relied upon input-output analysis and required allocating final demand among the major types of goods and services consumed. Industry employment was then estimated using the input-output inverse matrix to determine the output in employment required from each industry supplying materials or services to produce the end product. The second procedure involved the use of regression analysis to estimate employment in each industry. Equations were developed which were related to industry employment in the past two decades with different economic variables considered to be strategic in determining long-run changes in employment. The BLS also studied some industries individually to determine the factors expected to influence their future growth. This approach was used primarily for industries in which past employment were not indicative of future needs and for which their model had provided unacceptable results. The results obtained from input-output analysis, individual industry studies, regression equations and qualitative information concerning the technology and structure of the industry were used to determine employment projections for each industry. In the third method the BLS translated industry employment into occupational employment by developing occupational projections for each industry for 1980. The occupational structure of each industry was projected from historical statistics and other factors expected to influence occupational structure, such as new technology and changes in products. Employment requirements for most occupations were derived from the projections of total industry employment and the occupational patterns for that industry in 1980. Some occupations are affected by their own complex set of social and economic variables and the BLS analysis of the factors affecting employment were used as the basis for estimating future requirements.

Roger Bezdek (8, 9, 10) and others have also combined both techniques. A macro forecasting model which combines an economic growth model, an activity industry matrix, an inter-industry employment matrix, and the industry occupation matrix developed by the BLS has been used to re-estimate BLS projections for engineers and scientists.

<u>Analysis of Federal Contractual Obligations</u>. The third technique is more limited in its scope and time period. It rests on the thesis that there presently exists within a number of government agencies sufficient data to make short-run projections of the effects of defense contracts on industrial manpower requirements within occupational categories. One of the first attempts to review, evaluate and use the existing data was undertaken by Robert Aronson. (77) He concluded that, "...existing sources of data of federal expenditures on scientific and technical manpower can provide useful results in measuring the program-employment relationship. The results obtained, however, represent only broad and approximate relationships. The manpower planning in connection with federal programs, data that are more detailed and more precise and more compatible with a variety of analytic measures

of activity will be required." A study completed by the National Planning Association (44) is also indicative of this approach. A prospective $400 million award by the Navy in January 1971 to the Electric Boat Division of the General Dynamics Corporation of Groton, Connecticut for the construction of a nuclear submarine formed the basis of the NPA's approach. The objective of the NPA project was to obtain and identify that data which already exists in the Department of Defense (DOD) and other federal agencies to prepare projections of the manpower requirements by occupation likely to be generated by the Electric Boat contract. Five year projections of total staffing are prepared by contractors and listed with the Department of Navy. These projections are based primarily on work already contracted for. The NPA concluded that federal contract compliance in equal opportunity employment also gave complete occupational and skill breakdowns of all Electric Boat Company employees. Staffing needs were calculated byaggregating the number of man-hours to be expended on each vessel built, converted or repaired during a given period of time. The number of man-hours were converted into staffing needs based on necessary number of hours of work per period. These procedures required knowledge of dates on which ships would commence construction and the total number of man-hours likely to be expended on each ship and the pattern of distribution of man-hours during the time the ship is worked on. One source of information of attrition, layoff and recall was the local Employment Service office. The anticipated increase in staffing needs during 1973 were distributed among the various occupations employed at Electric Boat in the same proportion as these occupations had been employed during the previous period as reported by the Maritime Administration. The NPA assumed that the proportions in each occupation would remain the same as new hires took place. They assumed new hires would stay on the job because of collective bargaining or company practice. The NPA concluded that it is possible to compute the number of new hires in each occupation which would occur at the entry level with adjustments for apprentices and learners. Other conclusions of the NPA (44) study were that present techniques and data sources make it feasible to make projections of job opportunities by occupation generated by large federal contracts approximately a year or more in advance and periodic monitoring and updating of the projections can make them sensitive to changes in production schedules and contractor work loads. One of the major weaknesses of the Federal contractual obligations approach is that of estimating the multiplier and other indirect effects of procurement contracts.

The first efforts at manpower projections in the United

States were concerned with the supply of labor. Most efforts were concerned with projecting the size of the labor force by age, sex and race based primarily on demographic factors and judgments about labor force participation rates. Less work has been done on projecting supply by skill and occupational training. This is primarily due to the lack of a baseline or inventory of the supply of existing skills as of a particular date from which projections may be made. The baseline data that is available is concerned with current enrollments and recent graduates of specific courses, majors in programs in vocational schools, enrollments in engineering and science programs and apprenticeship programs. The Bureau of the Census and the Bureau of Labor Statistics have been criticized for ignoring the skill content of jobs and for basing occupational data on socio-economic status rather than on realistic assessment of the type of work performed. Two recent attempts to give a skill content to occupational data have been made by R. S. Eckhaus (16) and James G. Scoville. (65) Eckhaus (16) used information contained in the Labor Department's estimates of work or trait requirements of 4000 jobs. He first translated levels of general educational development (GED) into years of education and levels of specific vocational preparation into months of training time and then used data from the 1950 population census to estimate the years of schooling and periods of training in each industry in 1950. Scoville (65) developed estimates of the levels of education and training required by all census occupations in 1956. He used Eckhaus' translation of GED and SVD levels into years of education and training and based his study on requirements of 4000 job titles found in the 1949 edition of the Dictionary of Occupational Titles (DOT). Scoville's (65) work represents an attempt to assign specific educational and training requirements to detailed census occupations.

Bezdek and Getzel (10) have estimated education for 16 engineering or scientific occupations by using conversion tables for the Department of Labor results from the Bureau of Census occupations. A major source was the 1966 Bureau of Employment Security's third edition of Dictionary of Occupational Titles which presented for each of 14,000 job titles, "the amount of general educational development of specific vocational preparation required for workers to acquire knowledge and ability for average performance in a particular job." The authors estimated the years of education and training for 10 of 16 occupations in engineering and the sciences.

Recent efforts, particularly that of the BLS, has focused on the demand side of manpower associated with a particular Federal program. The set of alternative assumptions concerning national economic and social goals most often employed in forecasting is a variation of the following three possibilities:

1. a "status quo" federal budget during which the economic parameters will grow as they have in the recent past,
2. a "social welfare" budget where there is a major national commitment to domestic economic and social programs and a cutback in defense and aerospace funding,
3. a "defense" budget where there is an increase in military commitments and a reduction in domestic programs.

Examples of the use of alternative federal priorities are studies by the National Planning Association (NPA) (45) and the Bureau of Labor Statistics supported by the National Science Foundation. Both studies estimated the direct and indirect requirements for scientific and technical personnel due to national pollution control requirements. The three alternative assumptions used by the NPA were:

1. A "baseline scenario" consistent with the minimal level of pollution abatement in the late 1970's,
2. A "present policy scenario" allowing for the types of abatement expected to result from existing legislation as it goes into effect and is implemented by the industry between 1970 and 1980, and

3. The "environmental goals scenario," an attempt to achieve a 100 per cent abatement of most types of pollutants by the mid-1980's.

Five manufacturing industries were selected: food, paper, chemicals, primary metals and petroleum refining. The employment effects of the baseline scenario were estimated with the use of the BLS data which are estimates of employment by industry in the 1980's based on a sampling of industries in manufacturing. In the case of the labor force in construction, construction outlays representing wages and anticipated average earnings were projected for total employment created by these expenditures. Projections of scientists and engineers were made on the basis of their occupational distribution in the construction industry from the Department of Labor's Occupation by Industry Matrix of 1980. The NPA (45) took dollar volume that they thought would be created by new demand as a result of environmental pollution laws and put them into the framework of manpower requirements.

The NPA's (45) results are given here in some detail because of the general interest in the relationship between pollution controls and the demand for engineers and scientists. Their preliminary findings are:

1. Presently available techniques make it feasible to anticipate the future scientific manpower requirements generated by expenditures in pursuit of national goals.

2. Given the minimum level of pollution abatement in the baseline scenario which were where things were in 1960, growth in output would lead to increases in requirements for scientific manpower.

3. A high priority pollution abatement would significantly enlarge the share of economy-wide work force of scientists and engineers employed in these five industries from 12½ per cent to 18 per cent.

4. While most engineers and scientists are expected to be employed during 1980, more than half of the increment beyond the baseline consists of greater requirements for scientists.

5. Most of the growth in the utilization of scientists is expected to represent greater utilization of chemists and approximately 3/5 of the anticipated requirements are expected to take place in the chemical industry.

6. Additional direct employment for scientists is primarily attributable to research and development.

7. Data indicate that the ratio of scientific manpower to total production workers may be increasing especially if the environmental goals policy scenario, which is the most stringent of all the pollution abatement projections made, is assumed.

Data on Engineers, Scientists and Technicians

There is a considerable amount of manpower data on engineers and scientists. Most of it has been collected and reported with the cooperation of the Bureau of the Census, the Bureau of Labor Statistics and the National Science Foundation. The two principal sources of data on engineers and scientists are,

1. Household interviews, including the decennial censuses, monthly current population surveys and special household surveys, and

2. Employer surveys, including industry censuses, monthly payroll reports from individual firms, and special industry studies.

Data is therefore available from both the occupational and employment side and from the expenditure side. These have been reported in the following studies.

1. A study done by the National Science Foundation, NSF 68-30, Employment of Scientists and Engineers in the United States, 1950-1960 (49) gives time series data categorizing engineers and scientists and has been revised to include 1967-1970.

2. National Patterns of R&D Resources Funds and Manpower in the United States 1953-1972 (48). The original

publication covered 1953 to 1968 and has been updated to include 1969-1972. Figures are by expenditures and performance in both the public and the private sector.

3. An annual survey of federal agency expenditures for scientific activities. The National Science Foundation has gathered data from several agencies on their expenditures for scientific activities for R&D work.

4. The Bureau of the Census in its Census of Manufacturers goes out to industries to ask them what kinds of expenditures they are making for R&D work.

5. Bureau of Labor Statistics, Scientific and Technical Personnel in Industry, 1969 BLS Bulletin 1723. (81) Manpower data. Data gathered on manpower by industry, number of engineers, scientists and technicians in private industry. This time series which ends in 1970 was supposed to have been merged into a national occupational survey which was first tried out in manufacturing in 1971. The concept was to go back to the state manpower agencies and develop the occupational data from the state level by trying it first in manufacturing. In 1972 this was supposed to be extended to the service sector. Difficulties, however, were run into in getting the data out of the 1971 national occupational survey. As a result of these difficulties the national occupational survey has been terminated. This survey provided

time series data on scientific and technical personnel in industry. The BLS is no longer gathering data on scientific and technical personnel based on industry surveys; however, there is some indication that the BLS will work with those states who can build up a manpower employment series.

6. A post-censal study conducted by the Bureau of the Census with the National Science Foundation as a followup to the 1970 census data.

7. Data reported by federal agencies on their employment of engineers and scientists. This includes the Department of Defense, NASA-Economic Information Systems and the United States Civil Service Commissions Occupations of Federal White Collar Workers.

8. Data on EST's collected by special labor market programs administered by the Department of Labor including TMRP (74) and National Registry for Engineers. (67) These provide data on age, occupation, training and salary of engineers.

9. A report of the Office of Scientific Personnel, National Research Council (47) which is based on the results of a study and survey of doctoral departments in United States universities in the winter of 1970-1971. The survey sought to determine the current employment status of recent recipients of the doctorate and immediate postdoctoral

candidates in the sciences and engineering. It doesn't discuss the employment situation of older doctoral scientists and engineers. In addition the study reports some background data from doctorate survey files which indicate long-term trends in scientific and engineering fields. It is based on data from the National Science Foundation reports, U. S. Office of Education, National Endowment of the Humanities and the National Institutes of Health. Included in this study is employment information on Ph.D.'s who graduated in 1970 and mid-year 1971.

The Uses of Forecasts

There are four uses of manpower projections of engineers, scientists and technicians:

1. Educational planning. Decisions concerned with physical facilities, finances staffing, curriculum and enrollments.

2. Federal budget allocations. Decisions and lobbying for federal support of a particular program based on projections.

3. Vocational guidance for counseling and guidance purposes.

4. Employment by firms. Use by companies enable firms to adjust their hiring.

In current practice educational planning is decentralized and usually occurs at departmental levels. In professional programs, such as engineering, it may take place at the college level. As a consequence of this decentralization and because individual departments comprise a very small share of the total market little use has been made of national projections. This has been less true in engineering schools and graduate schools that train a significant portion of each year's graduate engineers and science students. Three recent events have taken place which point to a greater use of projections and a desire to bring supply into some relationship with demand. One, is the decline in the rate of increase in college enrollments which is expected to continue into the foreseeable future. Two, is a decline in teaching opportunities and three are the budgetary restrictions facing institutions of higher education. These three events have led to greater emphasis on planning at the institutional level. There is some indication that engineering schools are taking the general predictions of forecasting into account in shaping their curriculum. This has occurred particularly in planning for the biological sciences and in environmental topics.

With regard to Federal budget allocations, the BLS presently has the capability to estimate the manpower demand of Federal expenditure programs. Employment impact studies have been done on broad government demand categories and on certain specific programs.

The use of projections in lobbying for federal support usually means a request for more funds and projections are used only as indications of how much more will be requested.

In vocational guidance, vocational educators have been among the major demanders of more and better occupational forecasts. Since each counselor and counselee affects such a small portion of the total market, national projections are of less interest than local or regional employment prospects. Public agencies at the regional and county levels, such as planning agencies, have begun to offer local projections and should be encouraged to engage in this activity.

Large firms employing significant numbers of engineers and scientists engage in forecasting for recruiting purposes usually at the entry level. Roderick, (62) in an examination of 21 firms, reports that most firms engaged in some forecasting, usually for one year and almost entirely from the demand side in the form of numbers, degrees and specialties required. Forecasting is based on future business activity and the projection of turnover. The greatest difficulty of firm efforts was in establishing a relationship between the engineering work and final production. Roderick (62) concluded that recruiting was practically their only use and even here forecasts were accorded no credibility by those responsible for carrying out staffing operations. They were treated as internal exercises and ignored.

Conclusions and Recommendations

1. Data on employment of engineers and scientists is available from the BLS-NSF time series based on firm surveys. The Bureau of Labor Statistics time series for the period 1950-66, updated, represents the best data source of employment in engineering and the natural and physical sciences. Published by the NSF it is based on the annual BLS survey of scientific and technical personnel in industry and adjusted slightly to include self-employed persons and persons employed in firms smaller than those included in the initial BLS survey. It is recommended that this series be renewed.

Aronson's (77) study which was limited to projecting scientific and technical manpower as a result of federal programs offered the following comments on present data sources and suggestions for improvement. He concluded that a limited capability exists for measuring the employment effects of federal programs in the field of scientific and engineering manpower. Among the basic problems of measurement in demand for scientists and engineers is that measures of demand or requirements for manpower must be directly related to measures of output such as total employment or the output of goods and services. Data problems in estimating the effect of federal spending on employment of scientists and engineers were encountered mainly in the measurement of output or expenditure. Information on man-year expenditure is specific to occupational groups, field of science or engineering and character of work. Employment data are reasonably adequate for most sectors, although the degree of detail varies among the sectors. For practical purposes, measurement of federal employment effects are also inhibited by several conceptual problems. The most significant of these is lack of systematic rationalized and operationally feasible conceptual framework for relating the physical services of the federal programs to measures of employment. This study also concluded that given the present state of information on the employment of engineers and scientists, preference for one or the other estimating approach cannot be easily made. Either the budget method of estimation or the industry transactions approach give results that appear reasonable, although to cover all major dimensions of scientists and engineer employment in the study both approaches are necessary. The budget approach at present provides more insight into the sectoral and functional dimensions of the federal employment impact, but is weak on the occupational and program dimensions. The inter-industry transactions approach, in contrast, is somewhat stronger in these two respects. Finally, Aronson (77) recommended that the general strategy for developing data adequate for scientific and technical manpower planning in federal programs should be improvement of existing data sources rather than development of a single integrated data system. He called for greater coordination and compatibility among the sources of employment expenditure data buttressed by periodic manpower benchmark surveys for federal involvement.

2. Considerable employment data by occupation is available from federal agencies, with which to project the effects of government procurement policies in specific firms and areas. An early warning system is therefore feasible for major contractors where the firm has had to project its manpower requirements. The response to such early warnings by public manpower agencies is dependent upon the wide spectrum of demands for the agency's resources. In the NPA (44) Electric Boat Company study, state agencies had to weigh requests at Groton against alternative demands for training throughout the state. Two other areas also serve to limit the effectiveness of early warning and demand requirements. One is the uncertainty surrounding the awarding of a federal contract and the second is the unwillingness of public agencies to commit themselves to a manpower program in advance of the actual need.

3. The present state of the art of projection is a mix of the use of both input-output analysis and regression

analysis in completing a forecast. It appears judicious to continue to encourage the mix. A small number of efforts have been made to reconcile the alternative projections on data sources. The National Planning Association, (45) in comparing the 1960 NSF study results with the BLS national industrial-occupational matrix, concluded that the matrix was slightly higher than the firm studies. Figures were closest for chemical, civil, industrial, metallurgical, and mining. Data numbers that were off by the most appear to be electrical. The BLS matrix is also higher in aeronautical where the 1960 census shows more than 1960 BLS matrix projected. EST's from aeronautics may move to other activities. The census also counted fewer workers projected by the BLS matrix. One explanation is that people may cross occupations and so they are picked up in a different category in the census than the matrix projection. That is, people who report themselves as one kind of engineer wind up doing other kinds of work and report themselves or their households report themselves another way in the census survey. The National Planning Association (45) attributes the differences to census data based on a 5 per cent household survey in 1960 and a 25 per cent household survey in 1970, while the BLS sampled firms. In this study, they gave a heavier weight to the BLS data. The household surveys and the decennial census run the risk that individual family members may have only limited information regarding the employment of members of their family by such details as specific job title and occupation by industry. The NSF hopes to overcome this objection in its post-censal study by refining a sample. Because of these objections, survey data based on firm responses has been considered more accurate.

Bezdek (8) has also made comparisons between the BLS forecasts for 1975 and 1980 in his own results. He concludes that in each year there is a considerable difference in the estimates of total manpower requirements with considerably more variation for individual occupations than for aggregate occupational groups. He attributes some of this difference to the sensitivity of the projections to different policy assumptions of the respective forecasting groups. Such comparative studies should be encouraged.

4. The recent acceptance of both public and private forecasters of the need to employ the budget approach is to be commended. Stating different mixes of federal programs and national budget priorities eliminates the earlier criticism of forecasting in the United States. At the present time there appears to be no good reason to standardize assumptions nor to prefer one set of assumptions over others that have been offered. Rather the employment of various

mixes is to be encouraged.

5. There is a need to develop a reconciliation of data bases in use in the inter-industry national employment matrix and the inter-industry occupational matrix. The BLS is currently engaged in this activity.

6. Continuous work on obtaining standard occupational classifications which are sensitive to changes in the job content of occupations, particularly the character of work, is recommended.

7. It is useful to continue research that projects manpower requirements due to federal priorities and expenditures. If there is a shift from military priorities to social and domestic priorities, there is every indication that federal funds will still provide the major portion of the impetus.

8. Educational institutions should be encouraged to make greater use of forecasts.

9. Revenue sharing poses several issues for the forecasting of engineers and scientists. Projections for engineers and scientists have heretofore been concentrated at the national level. If local manpower funds are to be devoted to engineers and scientists forecasters will have to turn some of their attention to local markets. State and local manpower practitioners may be reluctant to devote resources and funds to engineers and scientists who are considered highly mobile.

B. Summary of Research and Demonstration Projects and Operating Programs

Allen, Thomas Lee. Aerospace Cutbacks: Impact on the Companies and Engineering Employment in Southern California.

Reemployment experience of a sample of unemployed engineers in Southern California who experienced over twelve months unemployment since July 1969. Econometric model of reemployment experience and statistical tests of the model with sample data. Also included summary of literature and analysis of reemployment programs.

Bain, Trevor. Defense Manpower and Contract Termination.

Reemployment experience of a sample of unemployed engineers, scientists, technicians and production workers in Tucson, Arizona in 1963-1964. Econometric model of reemployment experience and multivarite statistical tests of the model with sample data. Also includes results of application of computer program for identifying important subgroups.

Battelle. Final Report on a Survey of Aerospace Employees Affected by Reductions in NASA Contracts.

Reemployment experience of unemployed engineers, scientists, administrators, office staff and production workers across the country in 1968-1970. Includes information on income changes and mobility.

Brown, Thomas D. An Analysis of Reemployment and Unemployment of Engineers Laid off from NASA Aerospace Contracts between June of 1968 and October of 1970.

Reemployment experience of 718 self-classified engineers in 1968-1970 based on data collected by Battelle. Econometric models of asking salary related to unemployment experience and employment status related to personal and economic characteristics. Multivarite tests of the models with sample data.

Fishman, Leslie and Jay Allen, Byron Bunger, Curt Eaton. *Reemployment Experiences of Defense Workers: A Statistical Analysis of the Boeing, Martin, and Republic Layoffs.*

Statistical analysis of the data from three reemployment studies sponsored by the Arms Control and Disarmament Agency of layoffs in aerospace in 1963-1965 in Seattle, Denver and Long Island. Studies included engineers, scientists, technicians and production workers. Single and multiple regression analysis of reemployment experience with the use of personal characteristics and economic variables.

Loomba, R. P. *A Study of the Re-Employment and Unemployment Experiences of Scientists and Engineers Laid off from 62 Aerospace and Electronics Firms in the San Francisco Bay Area during 1963-65.*

Reemployment experience of a sample of unemployed scientists and engineers in the San Francisco area in 1963-65. Includes job search activities, job histories and occupational conversion.

Mooney, Joseph D. *Displaced Engineers and Scientists: An Analysis of the Labor Market Adjustment of Professional Personnel.*

Reemployment experiences of a sample of unemployed aerospace engineers in the Boston area in 1963-1964. Econometric model of reemployment experience and statistical tests of the model with sample data. Also includes discussion of job information channels and the effects of federal policies and funds on the engineering labor market.

Roderick, Roger D. *An Organizational Analysis of the Hiring of Engineers.*

Analysis of the employment policies and procedures for entry and experienced engineers based upon interviews with firms across the country. Includes extensive discussion of the development and use of manpower forecasts by companies, salary determination and a summary of labor market literature.

Thompson, Paul H. *The Effects of Unemployment on Engineering Careers.*

Reemployment experience of engineers in 1969-1971 on East and West Coasts. Includes sections on retraining, education and job counseling.

Turner, Robert G. and William M. Whitaker. A Survey of the Post Layoff Experiences of Aerospace Workers in Brevard County, Florida.

Reemployment experience of a sample of engineers, scientists, technicians and production workers in Florida, 1968-1971.

Aerospace Employment Project (AEP), National League of Cities and United States Conference of Mayors, Washington, D.C.

The Aerospace Employment Project (AEP), conducted in 1971, was designed to determine (1) whether the professional manpower needs of state and local governments related to Model City capacity building objectives could be met effectively, in part, from the ranks of unemployed aerospace and defense engineers and scientists, (2) whether a central organization of state and local governments can develop an effective interarea network in cooperation with State Employment Service agencies and professional associations, for selection, development, and placement, (3) whether professional skills available from unemployed aerospace and defense engineers and scientists can assist state and local governments in the development and utilization of new techniques in the solution of regional, state, and local problems, (4) whether a brief orientation and financial assistance for on-the-job development is necessary and adequate to aid the transfer of such personnel. Month-long orientation programs on state and local government affairs were conducted at MIT and The University of California, Berkeley.

American Institute of Aeronautics and Astronautics Employment Workshops (AIAA Workshops), American Institute of Aeronautics and Astronautics, New York City, New York.

The AIAA Workshops, conducted in 1970 and 1971, were designed to determine whether three sessions on job search techniques would aid reemployment. The three sessions included methods of finding employment, writing letters and resumes and interview techniques. Workshops continued to June 1973 with TMRP funds.

National Registry for Engineers, Department of Human Resources Development, Sacramento, California.

The National Registry, conducted from November 1970 to June 1973, was a national, computer based job bank system administered by the Department of Human Resources Development in Sacramento, California. Engineers, scientists and technicians placed applications directly with the Registry and employers placed job requirements directly with the Registry.

Skills Conversion Project, National Society of Professional Engineers, New York City, New York.

The Skills Conversion Project, conducted in 1971 with TMRP funds, was designed to determine (1) the identification of industrial fields for present and future utilization of technological skills, (2) identification of specific skills of unemployed engineers and scientists directly applicable to public and private service, (3) identification of fields which require skill conversion of product reorientation, (4) projections of professional job opportunities. Fourteen volunteer study teams investigated sixteen industries.

Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians (TMRP), U. S. Employment Service.

TMRP was conducted from April 1971 to June 1973 by the U. S. Employment Service. The program included (1) job promotion through special Engineers, Scientists, and Technicians (EST) Job Development Units in local offices, (2) job search grants to explore job opportunities outside their home areas, (3) relocation grants beyond normal commuting range, (4) on-the-job and institutional training with MPTA funds. Eligibility for the program was confined to engineers, scientists and technicians formerly employed at least twelve out of the last twenty-four months by aerospace or defense companies, or 21 months within the last five years.

Technology Utilization Project (TUP), National Society of Professional Engineers, New York City, New York.

The Technology Utilization Project (TUP), conducted in 1972 and 1973 with TMRP funds,was designed to determine (1) whether the technical skills possessed by aerospace and defense engineers could be transferred to civilian and public programs after a short orientation program (2) the requirements and content of such a program. Eleven programs were initially selected from those surveyed in the Skills Conversion Project. Training was conducted at academic institutions.

Volunteer Engineers, Scientists, Technicians (VEST), American Institute of Aeronautics and Astronautics, New York City, New York.

The VEST program was conducted from June 1971 to April 1973. It was a self-help program manned by unemployed, volunteer engineers, scientists and technicians to aid their own reemployment. Local VEST chapters across the country were established in conjunction with State Employment Service offices which provided housing and clerical support. The VEST chapters engaged in job development and conducted employment workshops.

BIBLIOGRAPHY

Note: DL 00-00-00-00 at the end of the citation indicates the U. S. Department of Labor grant or contract number under which the study was supported.

1. Allen, Thomas Lee. "Aerospace Cutbacks: Impact on the Companies and Engineering Employment in Southern California." Unpublished doctoral dissertation, Massachusetts Institute of Technology, Cambridge, Mass., 1972. DL 71-25-71-02

2. Alterman, Jack. "Interindustry Employment Requirements," Monthly Labor Review, Vol. 88, July 1965, 841-850.

3. American Institute of Aeronautics and Astronautics, Employment Workshops, Vol. 1: Final Report, Vol. 2: Analytic Report, Vol. 3: Workshop Handbook. Unpublished, AIAA, New York, New York. DL 82-36-70-01

4. Arrow, Kenneth J. and William M. Capron. "Dynamic Shortages and Price Rises: The Engineer-Scientist Case," Quarterly Journal of Economics, Vol. 73 (May 1959), 292-308.

5. Bain, Trevor. Defense Manpower and Contract Termination. Tucson, Arizona: College of Business and Public Administration, University of Arizona, 1968. DL 91-03-66-39

6. Battelle Corporation, "A Survey of Aerospace Employees Affected by Reductions in NASA Contracts." Unpublished, Battelle Corporation, Columbus, Ohio, 1971.

7. Benoit, Emile and Kenneth Boulding (eds.). Disarmament and the Economy. New York: Harper and Row, 1963.

8. Bezdek, Roger. "Alternate Manpower Forecasts for the Coming Decade: Second Guessing the U. S. Department of Labor," Socio-Economic Planning Sciences, Vol. 7 (1973), 511-521.

9. _______. "Manpower Implications of Alternate Patterns of Demand for Goods and Services." Unpublished doctoral dissertation, University of Illinois, Champaign-Urbana, Illinois, 1971. DL 91-15-70-47. NTIS-PB 200088

10. _______ and Barry Getzel. "Education and Training Requirements for Scientists and Engineers in 1966." Unpublished, University of Illinois, Champaign-Urbana, Illinois, 1973.

11. Blank, David M. and George I. Stigler. The Demand and Supply of Scientific Personnel. New York: National Bureau of Economic Research, 1957.

12. Brown, Thomas D. "An Analysis of Reemployment and Unemployment of Engineers Laid off from NASA Aerospace Contracts between June of 1968 and October of 1970." Unpublished doctoral dissertation, Harvard University, Cambridge, Mass., 1972. DL 82-11-71-30

13. Dalton, Gene W. and Paul H. Thompson. "Accelerating Obsolescence of Older Engineers," Harvard Business Review (Sept. - Oct. 1971), 57-67.

14. David, Deborah S. "Career Patterns and Values: A Study of Men and Women in Science and Engineering." Unpublished doctoral dissertation, Columbia University, New York, 1971. DL 91-34-69-11, 91-34-70-05

15. Dempsey, Richard and Douglas Schmude. "Occupational Impact of Defense Expenditures," Monthly Labor Review, Vol. 94 (December 1971), 12-15.

16. Eckhaus, R. S. "Economic Criteria for Education and Training," Review of Economics and Statistics, Vol. 66, No. 2 (May 1964).

17. Fishman, Leslie, Jay Allen, Byron Bungel and Curt Eaton. Reemployment Experiences of Defense Workers: A Statistical Analysis of the Boeing, Martin and Republic Layoffs. Washington, for U. S. Arms Control and Disarmament Agency (ACDA): Government Printing Office, 1968.

18. _______. ACDA, A Case Study of the Effects of the Dyna-Soar Contract Cancellation upon Employees of the Boeing Company in Seattle. Washington: Government Printing Office, 1969.

19. _______. ACDA, Reemployment Experiences of Martin Company Workers Released at Denver, Colorado, 1963-1964: Effects of Defense Employment Readjustments. Washington: Government Printing Office, 1966.

20. _______. ACDA, The Post Layoff Labor Market Experiences of the Former Republic Aviation Corporation (Long Island) Workers. Washington: Government Printing Office, 1966.

21. Folk, Hugh. The Shortage of Scientists and Engineers. Lexington, Mass.: D. C. Heath and Co., 1970.

22. Freeman, Richard B. The Market for College Trained Manpower. Cambridge, Mass.: Harvard University Press, 1971.

23. _______. "Engineers and Scientists for the Industrial Economy." Unpublished doctoral dissertation, Harvard University, Cambridge, Mass., 1968. DL 81-23-68-37

24. Gamble, Allen O. "Proposal for Development of an Improved Manpower-Related Information Program," in Toward Better Utilization of Scientific and Engineering Talent. Washington: National Academy of Sciences, 1964.

25. Ginsberg, Eli. The Development of Human Resources. New York: McGraw-Hill, 1966.

26. Grinter, L. E. "Report on Evaluation of Engineering Education," Journal of Engineering Education, Vol. 46 (September 1955), 25-63.

27. Holliman, Herbert J. and Allen E. Harger, "America's Technological Dilemma," Technology Review, M.I.T., July/August 1971.

28. Hansen, William L. "Professional Engineers: Salary Structure Problems," Industrial Relations, Vol. 3 (May 1963), 33-44.

29. _______. "The Economics of Scientific and Engineering Manpower," Journal of Human Resources, Vol. 2 (Spring 1967), 191-220.

30. _______. "The 'Shortage' of Engineers," Review of Economics and Statistics, Vol. 63 (August 1961), 251-56.

31. Helvey, T. C. "Short-Course to Re-Orient Engineers to the Field of Environmental Control Engineering." Unpublished, University of Tennessee, Knoxville, Tenn., 1970. DL 92-47-71-03

32. Hoos, Ida. Systems Analysis in Public Policy. Berkeley and Los Angeles: University of California Press, 1972.

33. _______. "Systems Techniques for Managing Society: A Critique," Public Administration Review (March - April, 1973), 157-164.

34. Leontief, Wassily W. "Statement," in Hearings on the Economic Effect of Vietnam Spending. Joint Economic Committee of Congress. Washington: Government Printing Office, 1967, 237-263.

35. _______. and Marvin Hoffenberg. "The Economic Effects of Disarmament," Scientific American (April 1961), 47-55.

36. _______, Alison Morgan, Karen R. Polenske, David Simpson and David Tower. "The Economic Impact--Industrial and Regional--of an Arms Cut," The Review of Economics and Statistics, Vol. 47 (August 1965), 217-241.

37. Lockheed Aircraft Corporation. "Job Hunting, The Seven Keys to Success." Unpublished, June 1970.

38. Loomba, R. P. A Study of the Re-Employment and Unemployment Experiences of Scientists and Engineers Laid-off from 62 Aerospace and Electronics Firms in the San Francisco Bay Area during 1963-65. San Jose, Calif.: San Jose State College, Manpower Research Group, Center for Interdisciplinary Studies, 1967. DL 81-04-27

39. Mangum, Garth L. and Arnold L. Nemore. "The Nature and Function of Manpower Projections," Industrial Relations, Vol. 5 (May 1966), 1-16.

40. Massachusetts Institute of Technology, The Department of Urban Studies and Planning. "Aerospace Employment Project Final Report." Unpublished, MIT, Cambridge, Mass., 1972.

41. Mooney, Joseph D. "Displaced Engineers and Scientists: An Analysis of the Labor Market Adjustment of Professional Personnel." Unpublished doctoral dissertation, Massachusetts Institute of Technology, Cambridge, Mass., 1965.

42. _______. "An Analysis of Unemployment among Professional Engineers and Scientists," Industrial and Labor Relations Review, Vol. 19 (July 1966), 517-28.

43. Myers, Charles. "Review of the Shortage of Scientists and Engineers," Journal of Economic Literature, Vol. 9 (December 1971), 1217-1219.

44. National Planning Association. "A System for Collecting Advance Information on Character and Extent of Employment Generated by New Government Contracts." Unpublished, NPA, Washington, D. C., 1972. DL 81-11-71-07

45. _______. "Assessing the Impact of Changes in National Priorities on the Utilization of Scientists and Engineers in the 1970's." Unpublished, NPA, Washington, D. C., 1972 and 1973.

46. _______. "Implications of New Legislation and New Federal Programs: Utilizing Persons with Engineering Backgrounds in the Health Related Industries." Unpublished, NPA, Washington, D. C., 1972. DL 81-09-70-16

47. National Research Council, Office of Scientific Personnel. Employment of New Ph.D.'s and Post-doctorals in 1971. Washington: National Research Council, 1971.

48. National Science Foundation. National Patterns of R&D Resources Funds and Manpower in the United States 1953-1972, NSF 72-300. Washington: Government Printing Office, 1973.

49. _______. Employment of Scientists and Engineers in the United States 1950-66, NSF 68-30. Washington: Government Printing Office, 1967.

50. _______. 1969 and 1980 Science and Engineering Doctorate Supply and Utilization, May 1971, NSF 71-20. Washington: Government Printing Office, 1971.

51. _______. Unemployment Rates and Employment Characteristics for Scientists and Engineers, 1971. NSF 71-20. Washington: Government Printing Office, 1971.

52. National Society of Professional Engineers. "Final Report of the Technology Utilization Project," Vols. 1-11 and "Executive Summary." Unpublished, NSPE, Washington, D. C., 1972 and 1973.

53. _______. "Final Report Skills Conversion Project," Vols 1-21. Unpublished, NSPE, Washington, D. C., 1972. DL 11-1-0534-000.

54. Naughton, Kathleen. "Characteristics of Jobless Engineers," Monthly Labor Review (October 1972), 16-21.

55. Norgren, Paul H. "Obsolescence and Updating of Engineers' and Scientists' Skills." Columbia University Seminar on Technology and Social Change, November 1966, unpublished. DL-MDTA 15-64.

56. Oliver, Richard P. "Employment Effects of Reduced Defense Spending," Monthly Labor Review, Vol. 14 (December 1971), 3-11.

57. _______. "Increase in Defense Related Employment during Vietnam Buildup," Monthly Labor Review (February 1970), 3-10.

58. _______. "The Employment Effect of Defense Expenditures," Monthly Labor Review (September 1967), 9-16.

59. Page, Donald. "Testimony Before the Joint Assembly Committee on Atomic Development and Space." Unpublished, California Department of Human Resources Development, Sacramento, California, January 1972.

60. Parker, John E. "Labor Market Behavior of Engineers and Scientists: An Analysis of the Aerospace Industry." Unpublished doctoral dissertation, University of Wisconsin, Madison, Wisconsin, 1963.

61. Pelz, D. C. "The 'Creative Years' and the Research Environment," IEEE Transactions on Engineering Management (March 1964), 23-29.

62. Roderick, Roger D. "An Organizational Analysis of the Hiring of Engineers." Unpublished doctoral dissertation, University of Illinois, Champaign-Urbana, Illinois, 1970. DL 91-15-69-51

63. Rutzick, Max A. "Worker Skills in Current Defense Employment," Monthly Labor Review, September 1967, 19-21.

64. Scherer, F. M. "Market Structure and the Employment of Scientists and Engineers," American Economic Review, Vol. 58 (June 1967), 524-31.

65. Scoville, James G. The Job Content of the American Economy. New York: McGraw-Hill, 1967.

66. Stanford Research Institute. The Transferability and Retraining of Defense Engineers. Washington: Government Printing Office, November 1967.

67. State of California, Department of Human Resources Development, National Registry for Engineers. "Registrant Data." Unpublished, April 1973.

68. _______, Professional Resources Development Center. "Phase Two Final Report." Unpublished, December, 1972.

69. The National League of Cities and the United States Conference of Mayors. "Aerospace Employment Project Final Report." Unpublished, League of Cities/Conference of Mayors, Washington, D. C., 1972. DL 82-11-71-22

70. _______. "Attachments." Unpublished, League of Cities/Conference of Mayors, Washington, D. C., 1972.

71. _______. "Perceptions of Former Aerospace Engineers in Local Government." Unpublished, League of Cities/Conference of Mayors, Washington, D. C., 1973.

72. Thompson, Paul. "The Effects of Unemployment on Engineering Careers." Unpublished, 1972. DL 81-25-72-10

73. Turner, Robert G. and William M. Whitaker. "A Survey of the Post Layoff Experiences of Aerospace Workers in Brevard County, Florida." Unpublished, Florida State University, Tallahassee, Florida, 1972.

74. U. S. Department of Commerce, Bureau of the Census. Characteristics of America's Engineers and Scientists: 1960 and 1962. Technical Paper No. 21. Washington: Government Printing Office, 1969.

75. _______. "Input-Output Structure of the U. S. Economy: 1963," Survey of Current Business, Vol. 49, No. 11 (November 1969), 16-47.

76. U. S. Department of Health, Education and Welfare, Office of Education. Projections of Educational Statistics to 1978-79. Washington: Government Printing Office, 1971.

77. U. S. Department of Labor, Bureau of Labor Statistics. Federal Spending and Scientist and Engineer Employment. Bulletin 1663. Washington: Government Printing Office, 1970. Authored by Robert Aronson.

78. _______. Occupational Employment Patterns for 1960 and 1975. Bulletin 1599. Washington: Government Printing Office, 1968.

79. _______. Patterns of U. S. Economic Growth. Bulletin 1672. Washington: Government Printing Office, 1970.

80. _______. Projections 1970: Interindustry Relationships, Potential Demand, Employment. Bulletin 1536. Washington: Government Printing Office, 1966.

81. _______. Scientific and Technical Personnel in Industry. Bulletin 1723. Washington: Government Printing Office, 1969.

82. _______. Tomorrow's Manpower Needs. Bulletin 1237, Vol. 4. Washington: Government Printing Office, 1971.

83. U. S. Department of Labor, Manpower Administration. "Technology Mobilization and Reemployment Program for Engineers, Scientists and Technicians, Handbook of Instructions." (Revised Edition) Unpublished, 1971.

84. _______. "Technology Mobilization and Reemployment Program Summary of Program Activity, May 21, 1971-July 5, 1973." Unpublished.

85. U. S. Department of Labor, Office of Information. Unpublished release, December 12, 1972.

86. University of California, College of Environmental Design and University Extension, Aerospace Orientation Program. "Adapting Professional Manpower from Aerospace to Urban Government." Unpublished, 1972.
DL 82-11-71-22